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reason why Ranger's *the* fun-to-drive small pickup. And Ranger XLT can even muscle up a husky 2.9L EFI V-6 if you need it. That's 140 horses.

SMOOTH RIDER.

When you're out there having fun, beat those bumps with Ranger's Independent Front Suspension. Two-wheel drive or four-wheel, it's Ford Ranger for that *smooth* ride.

6/60 WARRANTY.

Covers powertrain for 6 years/60,000 miles, body panel rust-

SPECIFICATIONS

RANGER POWERTRAINS

STX—2.9L EFI V-6
XLT/Custom—2.3L EFI
2.9L EFI V-6 Optional
S-Model—2.0L
5-Speed Manual O/D
Automatic O/D Optional

RANGER PAYLOADS

1205-1625 lbs.

MAJOR XLT STANDARD EQUIPMENT

Power Steering
Power Brakes
AM/FM Stereo Cassette
P215 Radial Tires
Interval Wipers
...and more!

RANGER XLT CABS

Regular—Seats 3
SuperCab—Seats 5

through for 6 years/100,000 miles.

Restrictions and deductible apply.*

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Participating dealers back their customer-paid work with a free Lifetime Service Guarantee, good for as long as you own your vehicle.*

*Ask your Ford Dealer for copies of these limited warranties.

BEST-BUILT AMERICAN TRUCKS 7 YEARS RUNNING.

Based on an average of owner-reported problems in a series of surveys of '81-'87 models designed and built in North America. At Ford, "Quality is Job 1."



FORD RANGER

BUILT FUN TOUGH

This One



GXSL-FY6-H93H

Drive Away Your Dream Machine.
See your Pioneer dealer for a Truck Riders™ demonstration and you could win a free Toyota 4x4 Turbo and off-road accessories up to \$5,000*.

The World's First Truck Stereo Kicks Bass.

Introducing Pioneer's Truck Riders™. The first audio systems designed exclusively for trucks. Understand, this isn't a car stereo attached to a pair of car speakers. This is a complete truck sound system designed to work as one.

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Pioneer's tough new Truck Riders™. Go ahead. Kick some bass.



TS TRX-TRUCK Speakers



TRX-TRUCK AM/FM Cassette Deck

*Or enter by putting your name, address, and the words "Truck Riders" on a 3x5 card. Mail it to Pioneer Electronics, c/o Comar, 2030 E. University Drive, Rancho Dominguez, CA 90220. Entry must be received by January 15, 1988. Offer void where prohibited.

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TRUCK RIDERS™



PIONEER



79 COVER STORY

If Sgt. Pepper led his band into a recording studio today, he and the boys would definitely experience shellshock. With the latest technical advancements, it's no longer a place where artists go just to record albums.

—PM photo by Rich Cox and Chic Donchin/ABC



90 Breaking sound barrier



82 Power lifters



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86 Ski boat shootout

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86 Ski Boat Shootout

Six top tournament boats clash in a battle of speed, handling and flying roostertails.

EDITOR'S NOTES

Joining our staff this month as Automotive Editor is Tony Swan. If you're an auto enthusiast, that name may be familiar to you. Swan served as editor of *Motor Trend* magazine for almost 5 years before coming to POPULAR MECHANICS, and has been a very active race driver in Sports Car Club of America and International Motor Sports Assn. events. Needless to say, we're delighted to have someone with Swan's credentials join our editorial staff. It's yet another indication that we're totally committed to bringing you the highest quality information and entertainment in the pages of POPULAR MECHANICS. . . . In a recent survey, thousands of people across the country were asked to look at photos of well-known personalities to determine which of them was most recognized, which least. The researchers concluded that Bruce Willis is currently the most recognized face in America. And no wonder. The co-star of the popular television series, "Moonlighting," is also seen regularly on the tube as the spokesman for Seagram's wine coolers, and last year, launched a music career as well. It just so happens that we were planning to feature Willis on this month's cover anyway because of the new and unique technology used to record Bruce Willis' latest album, *The Return Of Bruno*. To get the real inside story, we asked *Billboard* magazine's ace reporter, Steve Dupler, to write the story. Dupler covers the music recording scene around the world for *Billboard*, which is the music industry's bible. In the course of researching our *American Hot Wax* cover story, Dupler managed to track down the reknowned recording engineer, John Vigran and countless other music industry technicians who are pushing the envelope of technology in this exciting field. . . . When someone mentioned that this month marks the 40th anniversary of the first supersonic flight, it seemed appropriate that we ask old friend Chuck Yeager to tell us what it was really like up there. Gen. Chuck Yeager (USAF-Ret.) has written for us before, on the subject of the so-called Orient Express, the futuristic spaceplane that will be able to fly from New York to Tokyo in 2 hours. This time, we asked Chuck to look not ahead, but back in time to his "Right Stuff" days, piloting the revolutionary Bell X-1 rocketplane. His personal account of the day he became the first man to break the sound barrier is the story of a single day that forever changed the world. . . . Cities like New York, where I live, are constantly being torn down and built up. An integral part of the process is the giant cranes that do the heavy lifting needed to build modern skyscrapers. Frankly, until recently, they just blended into the cityscape for me. But one day, I looked up at the top of a 56-story office tower under construction and saw a gigantic crane sitting up on top and wondered how in the world it got up there, and how it operated once it got there. If you've ever wondered the same thing, you'll find the story in this issue as fascinating as I did. . . . It's that time again for those of us who live in the northern part of the country. We batten down the hatches and get ready for another winter. What better time to plan and start your winter shop projects? That's what we think, which is the reason our November issue features a great big *Woodworking Guide* each year. I may be prejudiced, but I think this year's guide, which focuses on furniture making, is the best one yet. Home & Shop Editor Steve Willson, Shop & Tools Editor Joe Truini, and Associate Editor Tom Klenck have put together a doozie this year that shows you how to build a whole dining roomful of beautiful, classic furniture that you will be proud to live with. Plus, there's an excellent piece which can guide you through the thicket of designing your own furniture pieces. And there's more. No matter what your level of woodworking expertise, I hope you'll check out this terrific special section. 'Til next time.



Swan: living the job.

Joe Oldham
Joe Oldham

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Smoke Contains Carbon Monoxide.

18 mg "tar," 1.0 mg nicotine av. per cigarette, FTC Report Feb '85.

LETTERS

Way Upscale Stagecoach



I go for PM plans in a big way. You might recognize this stage as having started out as an 18-in. model that first appeared in the monthly PM in 1946. I scaled it up to roughly $\frac{7}{8}$ of full size and have driven it in many parades, rodeos and other events. It's all oak and I glued and pegged the body using about 560 pegs. The suspension works really well. The coach may be my favorite project of all the things I've lovingly built over the years—from jet engines to airplanes, radio transmitters, furniture, a Revolutionary War cannon for the Bicentennial, and a full-size model of Henry Ford's "Quadricycle." Thanks for the plans!

W. KENNY GUILLOT
BATON ROUGE, LA

Full Flashing

Proper chimney flashing should indeed be made of a cap and base sections as you described in *Homeowners' Clinic* (page 141, June '87), but didn't you neglect to show the base flashing stepped and interwoven with the shingles?

JUDSON D. BRYANT
HOUSTON, TX

Our primary concern was to describe the need for a cap flashing that folds over chimney base flashing. But,

PM stage plans were for an 18-in. model.

you're right, the drawing should have shown lapping base sections.

Caddy's a '64

It's not an Earth-shattering mistake, but you should know that the Cadillac used by Tubbs (*The Cars of Miami Vice*, page 85, July '87) is a '64 de Ville, not a '63 as you say in your caption. As the owner of a '63 Sedan de Ville, I spotted your error



Rear view shows careful canvas and leather strap work.

right away. Quick identification is made by size and shape of taillights and fins, and the front turn-signal lenses. The turn signals on the '63 are circle lenses under the headlights. On the '64 the lights are behind the grille, under the headlights. And on the '63 the fins were bigger.

JEFF KLIENER
ENDWELL, NY

Big Is Beautiful

My experience with an '86 Fleetwood (6000 miles) and an '84 Town Car (46,000 miles) fails to support your findings in *Battle Of The Behemoths* (page 57, Sept. '87). The Cadillac's leather seats are firm and comfortable. The finish, trim and metallic paint are good to excellent. The car tracks and holds the road well. I didn't expect a Corvette or BMW. I'm satisfied with Lincoln and Cadillac.

JOHN D. WILLIAMS
TALLAHASSEE, FL

We want no part of a fwd car, or one without a heavy steel frame under it. Our '87 Lincoln Town Car has the heavy-duty suspension and corners as if it were on rails. The leather seats are terrific on long trips.

KENNETH M. BISHOP
BETHLEHEM, CT

Quality First

Cadillac's dismal showing in your Brougham versus Town Car test should make us all sad. GM's inability to produce a world-class automobile is a reflection of spirit and pride being replaced by a "what's in it for me" attitude. Until American industry can turn itself around, I'll buy imports. We reach a point where our pocketbook speaks louder than our patriotism.

PETER FULTON FOSS
AUSTIN, TX

Bet You Can't Build Just One

As you can see, I made good use of the classic *Coaster Wagon* plans in your June '85 issue (*Three Classics You Can Build*, page 127). I built the first wagon for myself. When my grandchildren saw it, they all wanted one, too. So, I built

three more, as birthday presents for them.

I've built many projects from PM plans over the years and look forward to more. W. "SAM" DRESSEL
BELLEVUE, WA

What's A Packard?

In your *PM Owners Report* in the August issue (page 59), you use the headline *Ask The Man Who Owns One*. This has been the slogan of the Packard Motor Co. for many years. Shame on you for stealing it.

IGOR DE LISSOVOY
INDIAN LAKE ESTATES, FL



The Packard Brothers' cars date to 1899. Last one was a '58.

Well, we did clip it, and thought we could get away with it. The expression describes perfectly the PM's much-copied car owners surveys, which have been a part of the magazine since the Nash Rambler appeared in January 1951. The Packard name disappeared when the Studebaker-Packard merger closed down in '58. The company showed a sense of humor when they spoofed their own slogan in a dealer publication in 1915: "Ask The Man Who Owes For One."



Oak coaster wagons are replicas of Janesville design built from 1900 to 1934.

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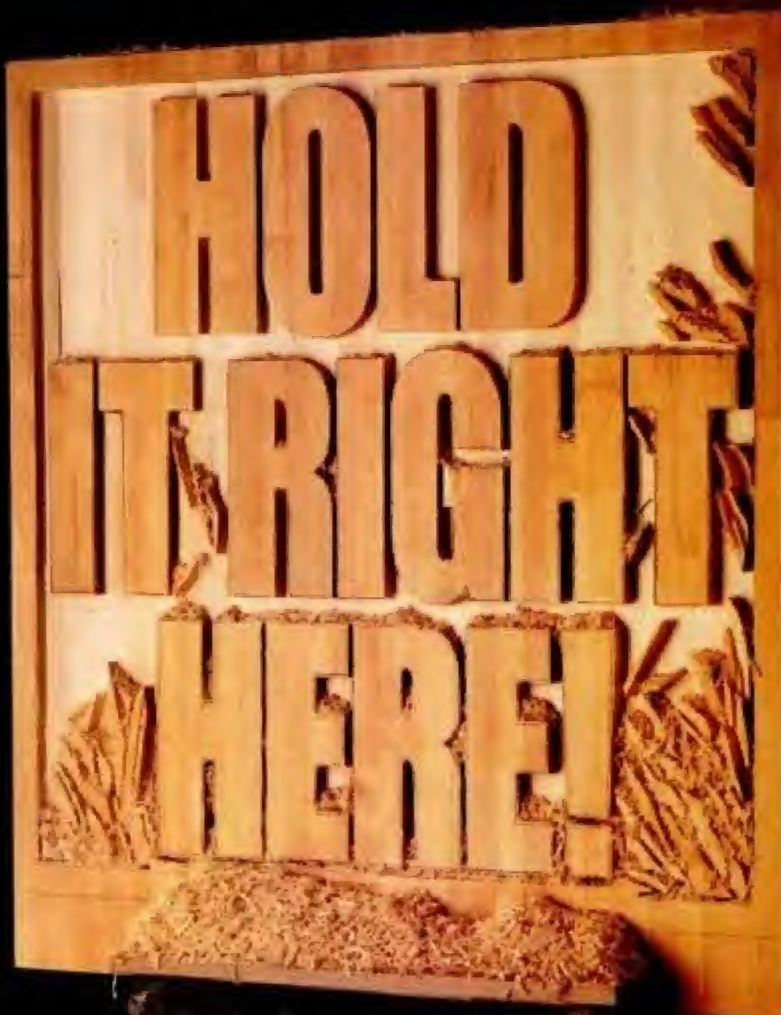
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BLACK & DECKER

ADVANCED NEW CHEVY.

The 1988 Chevy is the first all-new full-size pickup introduced in this decade. And one test drive will show how a truck that's new inside and out stands up to a truck that isn't all new. Big Chevy advantages from the top down:*

Chevy tops Ford in power. With a modern, fuel-injected Vortec V6 that gives you 15 more standard horsepower in the half-ton than Ford's old in-line 6 gives you even with fuel injection.

Chevy has a Getrag-licensed 5-speed manual transmission with overdrive. Ford doesn't.

Chevy has a new double A-arm independent front suspension. Ford doesn't.

Chevy has more glass area than Ford—933 more square inches of glass.

Chevy's big new cab gives you more leg room, more shoulder room and more total room than Ford.

Chevy has two-side-galvanized steel front, sides and rear—more of it than Ford.

Chevy gives you shift-on-the-fly Insta-Trac as standard equipment on all 4x4s. Ford still makes you stop, get out and change hubs.

Chevy protects the paint with a new clear-coat finish you can't get from Ford.

Chevy half-ton gives you a strong, massive new frame that's bigger and heavier than Ford's.

Chevy has a new all-welded cargo box with no exposed bolt heads to trap water and cause rust. Ford doesn't.

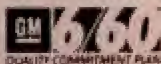
Chevy has special indentations in the cargo box that let you build a platform of 2x6s across the top of the wheelhousings for two-tier loading. Ford doesn't.

Feel the news behind the wheel. Test drive the first all-new full-size pickup introduced in this decade.* At your Chevy dealer's.

*Excludes other GM products.

Comparisons based on data available at time of publishing.

Let's get it together... buckle up.



See your Chevy dealer for terms and conditions of the limited warranty.

Best-backed Chevys ever. 6-year/80,000-mile powertrain warranty protection and 6 years or 100,000 miles of outer-body rust-through protection. Solid proof of the quality built into every new 1988 full-size Chevy pickup.

THE
Heartbeat
OF AMERICA



TODAY'S CHEVY TRUCK





OLD NEW FORD.

Ford says they're new. But you'll find their 1988 pickup doesn't have much new to talk about: taillight lens, revised fuel-tank capacities, tethered fuel-filler cap and integral alternator/generator.

IMPORTS

BY BILL HARTFORD

Horsepower-Happy Honda

A Civic with 105 horses and a 125-mph top speed? Outrageous! Is this a descendant of the Honda Civic that—in 1975—was a patriotic model of fuel efficiency? Was way ahead of Detroit with its socially responsible, clean-burning stratified-charge (CVCC) engine? The 1988 Civic CRX Si is indeed that car, but is certainly not an outlaw—not when it easily meets emissions standards and gets up to 35 mpg on the highway. What it is is a hot-rod economy car whose beauty is more than skin deep. At the heart of the Si is a multi-point-fuel-injected, 1.6-liter, aluminum-block Four with 16 valves. For '88, all Civics except the 62-hp, 50-mpg CRX HF have 4-valve-per-cylinder heads for impressive power from



Civic CRX Si: New look for the 105-hp, 125-mph economy car.

All the Civics—hatchbacks and 4-door sedans, too—begin yet another generation in '88. Honda, with the shortest product redesign cycle in the industry, played out its '84-'87 generation and is now on the market with the slickest Civics ever—smoother, longer, lower and wider. Interior volume gains are most pronounced in the 3-door hatchbacks. Still, the wagons, with their double-jointed seats and high-roof flexibility, are the roomy RVs of the Civic line. As a wagon fan, I would feel even more rotten if the '88 2wd model were available with the punch of 105 horses, having last year bought an '86 2wd version with only 76, less-than-exhilarating horsepower. Is it time to

trade-in already? From where? Those multi-valve heads, turbos, of course, and . . . a supercharger. A supercharger added to the MR2's 1.6-liter, 16-valve, twin-cam, fuel-injected Four gives the 2-seater a 30-percent increase in hp (see chart), and a 45-percent tweak in torque, to 140 lbs.-ft. Unlike exhaust-driven turbochargers—with their inherent throttle lag that makes you cool your heels waiting for the boost—the supercharger is belt-driven off the crankshaft, so every wiggle of your throttle toe is a kick.

Power is one thing, but getting it to the road and keeping it there is another. That's where the Celica All-Trac Turbo excels. A full 190 horses from its 2-liter Four are viscous-coupled to a full-time, all-wheel-drive system. The turbo's inter-

1988 TOYOTA POWER

Model	Displacement (liters)/Hp
Corolla (4-cyl., dohc, 16-valve)	
Sedans, wagon, coupe, hatchback	1.6/90
GT-S, FX16	1.6/115
Celica (4-cyl., dohc, 16-valve)	
ST, GT, Convert.	2.0/115
GT-S	2.0/135
All-Trac Turbo	2.0/190
MR2 (4-cyl., dohc, 16-valve)	
Hardtop, T-Bar	1.6/115
Supercharged	1.6/145
Supra (6-cyl., dohc, 24-valve)	
Supra	3.0/200
Supra Turbo	3.0/230
Camry (4-cyl., dohc, 16-valve)	
Sedans, Wagons	2.0/115
Tercel (4-cyl., sohc, 12-valve)	
Liftbacks, Coupes	1.5/78
Wagons	1.5/62
Cressida (6-cyl., dohc, 12-valve)	
Sedan	2.8/156



Corolla GT-S noses into '88 with a 0.33 Cd.

cooler uses engine coolant to lower compressed intake air temperature. All-wheel drive is added to the Camry sedan, too, but its 2-liter Four gets no more hp. Like last year, 115 horses come from Toyota's twin-cam design and the quiet opening and closing of 16 valves. **PM**



Faster wagon: The 4wd model gets 105 hp, too.

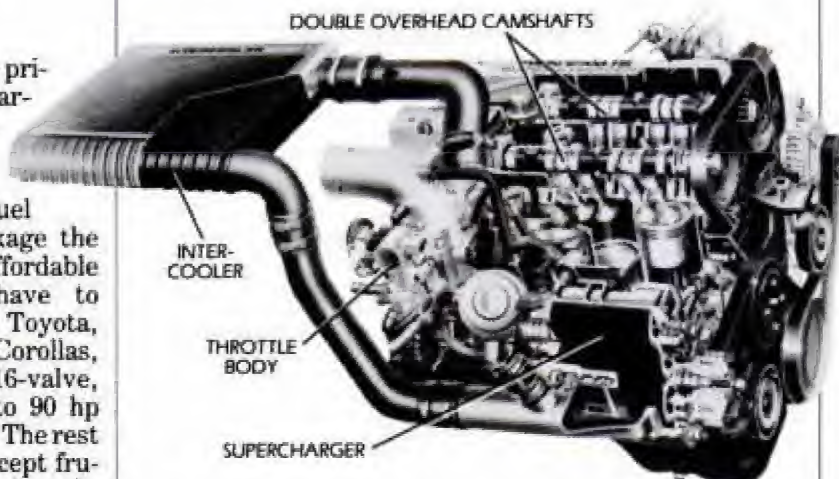
their modest-displacement sohc Fours, and all are fuel injected. But, only two models—the Si and the 4wd wagon—use the 1.6 with its 105 hp (see chart).

16-VALVE CIVICS

Model	Displacement (liters)/Hp
3-door Hatchback	
Standard	1.5/70
DX	1.5/92
4-door Sedan	
DX	1.5/92
LX	1.5/92
5-door Station Wagon	
2wd	1.5/92
4wd	1.6/105
2-seat CRX	
CRX	1.5/92
Si	1.6/105

Twin-cam Toyotas

Performance is the priority. Soon, if a car-maker can't get 100 horses out of a liter and a half, maintain good fuel economy and package the power in an affordable econobox, he'll have to close up shop. At Toyota, the redesigned Corollas, with their new, 16-valve, 1.6, are now up to 90 hp (from 74 last year). The rest of the line, too (except frugal Tercels), gets breath-taking horsepower boosts.



New supercharger on the midship-mounted 1.6 cuts MR2 0-60 time.

Graduate School.

Mr. Goodwrench is constantly going back to school. Getting advanced training at GM Regional Training Centers throughout the United States. Taking courses in turbocharging, ABS braking systems, electronic instrumentation and all the latest

technology. So he knows how your GM car is supposed to work. And what to do if it doesn't.

The next time your GM car needs repairs, take it to the man who's factory-equipped with the latest technology... Mr. Goodwrench.

No one knows your GM car better. No one. Mr. Goodwrench has genuine GM parts designed specifically for your GM car. Including GM Goodwrench Brake Shoes and Disc Pads.



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ELECTRONICS

BY STEPHEN A. BOOTH

Improve Your Vocabulary



The thesaurus (left) and dictionary go electronic.

The computer is a wonderful contraption, but not everyone needs the multiple services that can be provided by an Apple or an IBM. Nonetheless, the computer's main attributes, deep memory and fast recall, can be harnessed for other worthwhile products and causes. And now someone has finally applied computer electronics to the dictionary, to make that useful reference tool even more usable.

The company putting the spark under Messrs. Merriam and Webster is Franklin Computer, of Pennsauken, New Jersey. The company's Language Master computer (\$300) packs an 80,000-word dictionary from Merriam-Webster

into a 1-pound, 7 x 5 x 1/2-in. package that runs on four AA batteries—and contains a 35,000-word thesaurus to boot.

To learn the meaning of a word, or to find a synonym for it, you simply spell the word on the typewriter-like keyboard and presto—the definition appears on the 4-line, 160-character, liquid-crystal display screen. That definition includes the word's part of speech, its various meanings and usages, and its proper hyphenation.

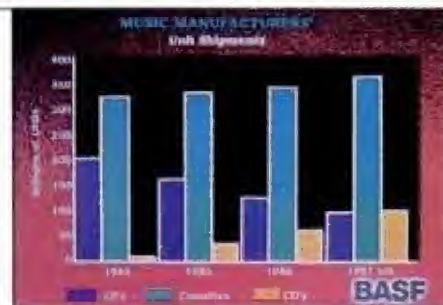
You could buy a conventional paper dictionary and save some \$275 plus the cost of batteries, but the book is a tough tool to use if you don't know how to spell the word you're looking up.

Here's where the Language Master makes innovative use of its computer heritage. All you need do is type the word the way you think it might be spelled, either phonetically or by leaving hyphens where you're stumped. Then, the Language Master will provide you with a list of correctly spelled words that sound like the one you entered. This feature is also available in Franklin's Word Master thesaurus (\$150).

Now Hear This

I've always believed that, given the chance, most people of unimpaired hearing can perceive differences in sound quality: not just bad from good, but also good from better.

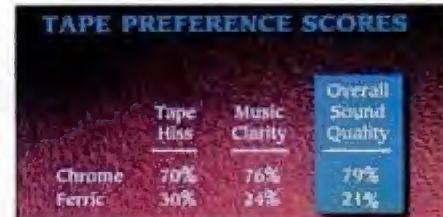
I also believe that in addition to this ability to differentiate among levels of quality, most people of



Prerecorded music cassettes outsell LP's and CDs, but sound can be improved.



In BASF study, tape purchasers say sound quality is of great importance.



sound mind will prefer the improved performance.

It seems as though my faith in humankind has been vindicated by a recent (Please turn to page 16)

Say! It Ain't So!

The tarpaulin's down, the actors have departed the stage, and in the lengthening shadows looms that damp, drizzly November of the soul so aptly described in *Moby Dick*. Yes, the baseball season is over. Some of us will seek refuge in football's weekend headlines and hype, but the true bug remains an outcast,

scanning the horizon for some glimmer of spring in the sports pages. Melville must have been a Giants fan—much as Walt Whitman's optimistic verse pegs him as a zealot of the Brooklyn clubs.

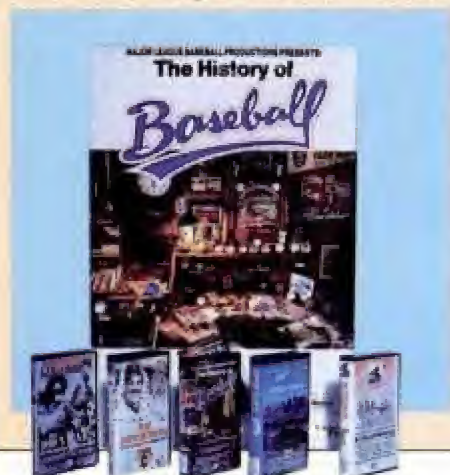
For some of us, the '87 season ended long before the World Series swept the nightly TV ratings. But no matter how your team finished, you can follow it all winter long thanks to a collection of videocassettes from Scotch Home Video. These include 13 team histories (\$20 each), a highlights tape (*This Year In Baseball*, \$15), and *The History Of Baseball* (\$20), a 2-hour chronicle of the pastime's development.

The *History* tape is a gem. For the early days and old-time greats of the game, it relies on black-and-white photos and films. (The first telecast didn't happen until August 26, 1939, when the Dodgers hosted NBC at Ebbets Field. Brooklyn and NBC brought color to the game also, on August 11, 1951. You could look it

up.) Whatever the image source, you'll see Ty Cobb and Lou Brock steal, Ruth and Aaron slug, Cy Young and Dwight Gooden hurl.

What this documentary shows is how little the fundamentals of baseball have changed in the 100 years since the batters stopped calling for a high or low pitch from hurlers who served underhand. The resilient sport survives despite league expansion, free agency, TV's ridiculous scheduling requirements, and yes, even Howard Cosell.

The stadiums have changed, and that's painfully evident in *A Giants History: The Tale Of Two Cities*. September 29, 1957, is Black Sunday to many in New York, for that's the day their beloved Giants departed The Polo Grounds and went west. This team history is among the best-made tapes, with the color footage commencing in San Francisco. The preceding 75 years are, appropriately, in black and white.



We interrupt this magazine to bring you an important television announcement.



What's the news? There's a complete line of high-technology Sylvania video equipment with something the competition doesn't have.

Simplicity.

We make every Sylvania audio-video component simple to hook up, simple to tune and simple to add on to your system.

Sylvania Superset™ II, for instance.



It's famous for its superior picture quality. It has built-in stereo sound. And now it comes with SuperRemote 44™ Plus with the simplicity of computer menu On Screen Tuning. So now you can control *all* TV functions with the touch of a button. You can control color, brightness, tint, sharpness...everything right from your

chair. Plus control virtually *any* brand of wireless VCR or cable system. Now you only need one remote control, not two or three.

And Sylvania VCRs are cable-ready with an absolute minimum of connections to make.

The big news in television enjoyment is simple. It's Sylvania.

SYLVANIA
AUDIO-VIDEO

It's Simple. It's Sylvania.

SYLVANIA PRODUCTS PRESENT THE GREAT HBO GIVEAWAY. SEE YOUR DEALER FOR DETAILS.

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WE CREATED A SHAVER THAT A SHAVE THAT DEFIES BELIEF.

The moment you pick up a Norelco® Rotatract®, you sense an entirely unique shaving experience in the palm of your hand. A beautifully balanced, surprisingly thin and light instrument. Not only designed to fit your hand, but also cleverly bent to reach your face (so you don't do a lot of bending and reaching yourself). Just flip it on (its quietness will astound you) and discover how a remarkably close and incredibly comfortable shave have come face to face.

WE HAVE LIFT OFF



The patented "Lift and Cut" system makes Norelco Rotatract the first shaver to give your beard a lift. With 45 lifters

and 45 self-sharpening blades, it's a dual-action system that goes a revolutionary step beyond. Each hair is lifted a split second before a blade cuts it off. So the shave is skin close. Yet, all this is possible without the blades even touching the skin.

IF THE BLADES DON'T TOUCH YOUR SKIN, HOW CAN YOU SHAVE SO CLOSE?

Very comfortably, thank you. Logic says a closer shave requires the blade be pressed closer to the skin. The Norelco system actually defies logic by doing exactly the opposite. Instead of the blade attacking the whisker, the whisker is brought to the blade.

For a close, comfortable, face-saving shave.





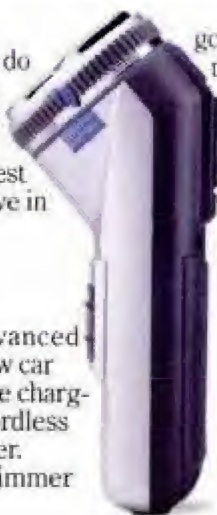
DEFIES LOGIC, TO GIVE YOU

WHY MORE HEADS INSTEAD OF ONE.

The hair-catching capacity of a shaver has a lot to do with the speed and quality of the shave. So Norelco has more than one head, each delivering 90 slots and a speed of 2000 r.p.m.'s to guarantee efficiency. They float to hug the contours of your face, negotiating even the toughest curves comfortably. And the circular shape lets you shave in any direction with no loss of effectiveness.

TECHNOLOGY FROM TOP TO BOTTOM.

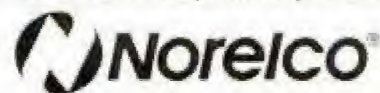
As you might suspect, such technologically advanced shavers come with almost as many features as some new car models. Such as a charge indicator light that blinks while charging, then stays lit fully charged. The option of cord or cordless shaving. The longest lasting charge of any leading shaver. Automatic universal voltage, and, of course, a pop-up trimmer for mustaches and sideburns.



On the 950RX and 850RX, a one-hour quick-charge good for two to three weeks of shaving and a special five-minute quick-charge for a three-minute cordless shave. And the 950RX gives you a comfort setting that adjusts to suit your skin type, plus a charge meter and alarm to monitor the shaver efficiency at any given moment.

THROW YOUR BEARD A CURVE.

Now that close is *this* comfortable, the Norelco Rotatract is the perfect solution to the problem you hate to face.



WHERE CLOSE AND COMFORTABLE COME
FACE TO FACE.

ELECTRONICS

(Continued from page 12)

test of music listeners conducted independently on behalf of BASF, the magnetic tape manufacturer. The goal of the test was to determine whether or not people could hear the difference between music recorded on two different types of tape, and if so, which tape's sound did they prefer. Specifically, it was a matchup between the normal-bias, ferric-oxide tape most record companies use for their prerecorded cassettes, and the high-bias, chromium-dioxide tape

that BASF sells for home recording.

Foremost among BASF's claims for chrome is that it has less background noise (hiss) than ferric tape. The quieter the tape, the more "headroom" there is for recording music on it before the tape's capacity to hold a signal becomes "saturated"—the point where distortion begins. The less distortion, the clearer the music will sound, and greater clarity is something the average prerecorded cassette would not suffer an overdose from. Like too many things in life, the quality of many commercially duplicated music tapes represents some-

one's idea of what's "good enough"—but it's not as good as it might be.

In fairness, today's mass-produced prerecorded cassettes sound better than their ancestors of even 5 years ago, thanks to the use of better grades of ferric tape, improved duplication procedures and Dolby noise reduction. But there's still room for improvement, and chrome tape is one item that would help things along. BASF already sells chrome to a handful of record companies, who use it for some of their releases (often, concerned artists with clout will demand high-quality production).

The BASF study clearly shows people can hear quality and do prefer it. I'll spare you the details of the testing procedure: Suffice it to say that everything was above board, and in no way was the deck stacked in favor of BASF or chrome. The 229 participants, ages 16 through 49 and split about evenly between females and males, did their listening in shopping malls in Atlanta, Boston and Columbus, Ohio.

All owned at least \$400 worth of sound equipment, bought at least five prerecorded tapes per year, and had music libraries in which prerecorded tapes, on average, accounted for 43 percent of the titles. Interestingly, some 94 percent of the participants said they had already noted differences in sound quality among the tapes they own.

When all was said and done, 79 percent of the listeners preferred the sound quality of chrome tape over ferric. Some 76 percent said musical tones were clearer on chrome, and 70 percent said they perceived less tape hiss. Even before the listening test, some 93 percent said that the sound quality of the tape itself was an important consideration in their decision to purchase a specific cassette. That's second only to the artist: 97 percent said the performer was their top consideration in a tape purchase. Price, considered by 74 percent to be important, placed third as a factor when buying a prerecorded music cassette.

What this tells me (and, I hope, the record companies) is that people can recognize improved sound, and appreciate the improvement enough to pay more for it. It needn't cost much more.

With prerecorded cassettes selling to the tune of 350 million a year, sheer volume would make the per-unit cost of improvement negligible, both at the manufacturing and retailing levels. Since cassettes are the dominant music carrier sold today, listeners, performers and music companies alike will benefit from better musical reproduction. **PM**



It can do so much, it's almost unfair to call it a sander.

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Speakers with 160 watts of
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Speakers with 40 watts of
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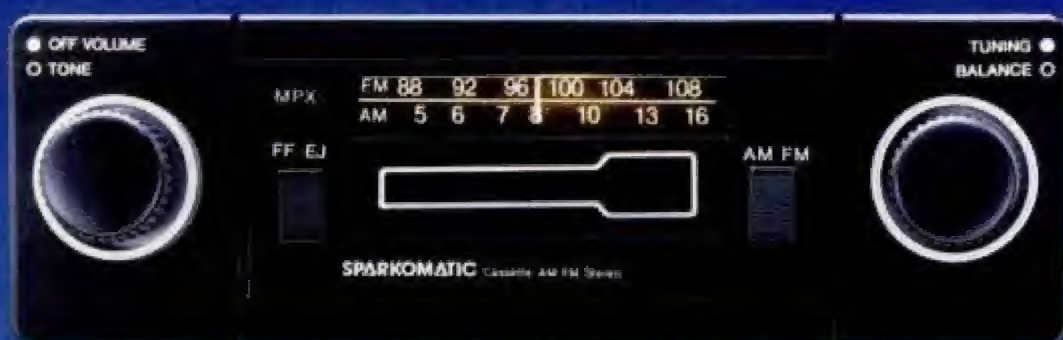


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with locking fast forward
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ETR AM/FM Stereo/
Cassette with
auto replay,
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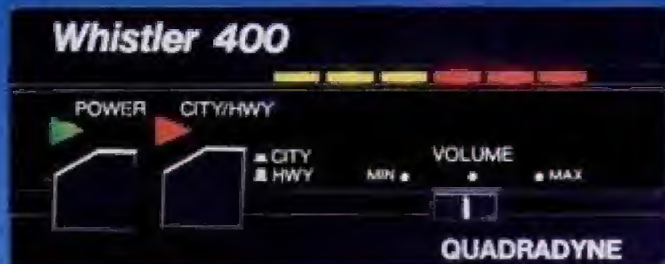
What's one of the nicest things about doing your Christmas shopping at K mart? Our layaway policy. Just a dollar down will hold your purchase in layaway. Get all the details in the store. And make buying the audio equipment they love at the prices you love a lot easier. To us, that's what being America's Favorite Store is all about.

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TIME MACHINE

75 YEARS AGO: November 1912

POPULAR MECHANICS



Taming the wilderness.

Getting There

Conquering distant frontiers with technology was a recurring theme in *POPULAR MECHANICS* when the century was new. One innovative plan called for the installation of an inexpensive monorail locomotive in the Alaskan outback.

It was presumed the gyroscopic effect produced by the spinning wheels would keep the contraption upright, and the single elevated track would be less expensive to build than the old conventional track.

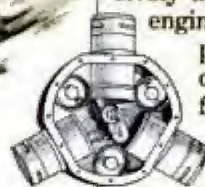


Redesigning the engine.

Round Engine

Motorcycling was still in its infancy, but already innovators were developing varia-

tions on the reciprocating piston engine. One notion placed three cylinders in a radial configuration 120° apart—an intriguing arrangement that was to be used extensively in aircraft. The little engine weighed a scant 10 pounds, but it developed a blistering 6 hp for a top-end speed of 50 mph. Power output followed a somewhat circuitous drivetrain, finally reaching the rear wheels of the motorcycle via a fixed driveshaft.



50 YEARS AGO: November 1937

Winds Of War

Europe was already on the march, and despite strong isolationist leanings, American defense contractors were coming up with brand-new weapons concepts. The *POPULAR MECHANICS* cover a half-century ago illustrated a light, fast, attack bomber that bristled with .30-caliber machine guns. Capable of attaining speeds in excess of 220 mph, the airplane as envisioned carried a crew of three people. Two gunners fired aft from ports on the top of the fuselage and from a trap door in the bottom.



Maintaining our traditions.

Preserve And Protect

The frigate *Constitution*, otherwise known as *Old*

Ironsides, was our oldest warship and a symbol of American Naval power. But age and harsh New England winters were taking a toll on the square rigger. PM reported that efforts were underway to design and install an air conditioning and humidity-control system on the main gundeck of the ship.

Oldest Gas Station?

The claim was made by a filling station owner in Lamar, Colorado, who placed his pumps outside a structure made of 6,000,000-year-old petrified wood.

POPULAR MECHANICS



Mastering pre-war skies.

25 YEARS AGO: November 1962

Shooting Sports

Gun fanciers have always looked for ways to extend the shooting season. PM's cover story 25 years ago this month suggested ways to equip for indoor target shooting using air-powered guns and .22-caliber ballistic arms. Our cover illustration showed an acoustical shooting box to dampen noise, and a PM-designed steel bullet trap shaped like a Venetian blind.

Blast Off!

The quest for speed spans the ages, and *Untouchable* represented the state-of-the-



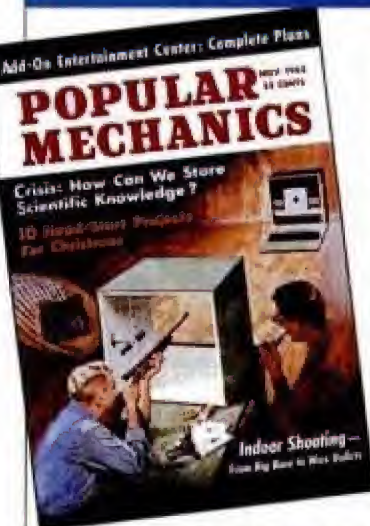
Making a stab at the record books with an engine on wheels.

art in speed record attempts a quarter-century ago. The driver sat in front of an engine scavenged from an F-86 Sabre Jet while 5200 pounds of thrust sent it on a 225-mph gallop. The car, an engine with wheels, was assembled by Romeo Palamides of Oakland, California.

Airplane Addicts

Also featured in November, '62, was a group of Seattle aviation engineers who built and flew aircraft replicas of famous antique aircraft in their spare time, including a 1912 Curtiss *Pusher*, World War I *Spad* and Fokker *Triplane*.

PM



Shooting for pleasure.

"Isuzu Trooper II. The 4x4 that conquered Everest."



What a snowjob.

The truth is, if you want to reach the top of Mt. Everest, you'd be better off driving a yak. On the other hand, you don't have to beat a Trooper II with a stick to get it moving.

Shift into 4-wheel drive and its fuel-injected 2.6 liter engine will eagerly take

you just about anywhere. Barren deserts. Snow covered streets. Muddy riverbeds. And *some* mountains.

Shift back into 2-wheel drive, and it'll eagerly take you through long stretches of highway or cramped supermarket parking lots. Or fold up the rear seat, making sure all rear seat passengers are gone, and



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you've got 71 cubic feet of storage space.

And unlike a yak, a Trooper II can be ordered with automatic transmission, captain's chairs, and 2-door or 4-door body styles.

The result is something that handles like a station wagon. Hauls like a Sherpa.

And looks like nothing else on or off the road. All for thousands of dollars less

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Looks like our rivals have slipped.

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CAR CLINIC

BY MORT SCHULTZ

Weeping Wiper

When we park our 1985 Chrysler LeBaron Town and Country so the right side of the car is tilted, windshield washer fluid leaks from the right wiper blade. The dealer installed a new pump, but it hasn't helped. LOREN COLLINS STOCKBRIDGE, MI

The windshield washer set-up in the LeBaron is called "wet blade," because the washer nozzles are attached to the wiper arms instead of being positioned on the cowl at the bottom of the windshield as in other cars. The hose from the fluid reservoir runs up the wiper arm and attaches to the nozzle.

Why the dealer installed a new pump is beyond me since it's obvious that fluid is leaking from a hole in the hose where it is in contact with the wiper arm. Here's how to confirm this:

Pinch the hose closed

where it attaches to the nozzle on the wiper arm. Have someone operate the windshield washers as you examine the hose. You'll see fluid squirting from a hole.

Who's Got The Button?

When my 1985 Nissan Maxima reached the 30,000 mile mark, the oxygen (O₂) sensor light on the dash came on as it was supposed to. Heeding the warning, I serviced the part as outlined in the service manual. So what's my problem? I can't find the widget mentioned in the manual that turns off that light. Where the manual says the switch is, it isn't. In fact, the wire color shown in the manual as belonging to the O₂ sensor light turns out to belong to the brake light. Do you have the answer?

JOHN O. BOCK
REDMOND, WA

As you've learned, you can't always trust service manuals, because manufacturers move things around after manuals are printed. The last Maxima I looked at had the odometer-to-O₂ sensor warning light relay under the left (driver's) side of the dash on the kick pad, but I won't lay money that it's located in the same spot in your car.

What you have to look for is an innocuous little metal box. That's the odometer-to-O₂ sensor warning light relay. There are a few little metal boxes under the dash, but don't let that throw you. The box you want is the only one with a spring-loaded button sticking out of it. Pressing the button turns off the lamp for 30,000 miles.

It's The Cat

My 1986 Oldsmobile Delta 88 has had a sulfur exhaust odor since day one. The dealer's excuses are "It will go away after a few hundred miles," "They all do it" and "You're not using a detergent gasoline." To his credit, the dealer has cleaned the fuel injectors, made the adjustments outlined in the service manual, checked the emission control systems, and installed a new L-2300 catalytic converter. The new converter got rid of the odor for 300 miles, but then that rotten egg smell returned as strong as ever.

ROBERT BREGENZER
JEFFERSON CITY, MO

Your car probably needs a new converter.

The elements in a catalytic converter include nickel to control exhaust odor and cesium to reduce oxides of nitrogen. GM recently advised us that the amount of nickel in L-2300 converters installed on a number of 1986 and 1987 models with 3- and 3.8-liter engines was insufficient to deal with the

sulfur content in gasoline. A new converter has been issued. If your Delta 88 meets the criteria—the dealer has to check the VIN to be sure—the part number of the new converter you need is No. 25103335.

The Right Mix

Thanks to the information in the April '87 Car Clinic (page 50) I was able to determine what was giving us fits with a 1982 Pontiac J-2000. You said the part needed to fix the condition is a mixture control solenoid with a stainless-steel tip to replace the mixture control solenoid with the rubber tip which has disintegrated. That new solenoid costs \$130, which is a hell of a price to pay when all I need is the tip—not the whole solenoid. I don't care if it's a stainless-steel or rubber tip. Can you tell me where to get it?

JIM SCHADE
STONE MOUNTAIN, GA

No can do, Jim. The mixture control solenoid with the rubber tip is ancient history. GM pulled it from the supply system when it discovered that the tip was falling apart.

The mixture control solenoid with the stainless-steel tip replaces it, but you can't get the tip by itself, because it's a fabricated part of the solenoid. The solenoid is included in a service kit (part No. 17111445) which also contains a retaining screw, seal and air-horn gasket.

Stranger Than Fiction

Let me take you back to the Aug. '87 Car Clinic, (page 24) in which Sam Abrams of Margate, Florida, described a 1985 Dodge Lancer with a left-front tire that was wearing bald on the inside. A wheel alignment technician showed Sam

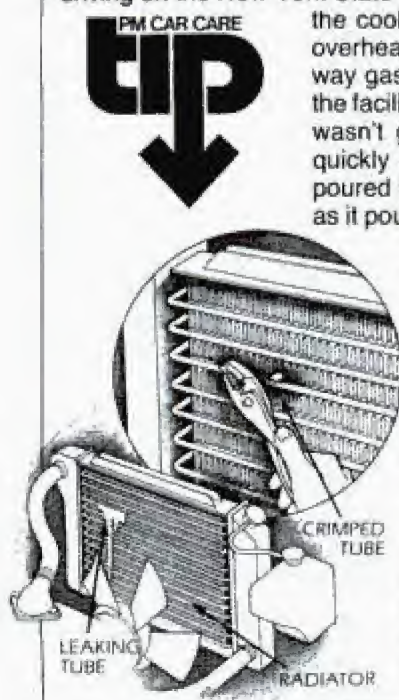
(Please turn to page 22)

A Little Trick To Get You Home

L.H. Kunkel of Ridgewood, New York, has a son who had a problem. A hole popped in one of the radiator tubes as he was driving on the New York State Thruway miles from home. All the coolant was lost, and the engine overheated just as he pulled into a thruway gas stop—one which didn't have the facilities to replace the radiator. He wasn't going anywhere, because as quickly as replacement coolant was poured into the radiator, that's as fast as it poured out. What to do? Which is

what the son asked the father when he called home.

"Take a pair of pliers," L.H. advised, "and tear away the radiator fins around the leak in the tube. Then use the pliers to crimp the tube closed, or split the tube in two and bend the ends closed." Those tubes running from one radiator tank to another are individual—it's possible to plug several by crimping them and even permanently soldering them and still have plenty of cooling capacity left.





Getting parts for your foreign car shouldn't be a big adventure.

Even if your car was made halfway around the world, you can still find parts for it right around the corner. Just look for the NAPA sign.

**NAPA gives you quality.
In quantity.**

Every NAPA AUTO PARTS store, garage and service outlet has access to more than 100,000 different parts. For all kinds of cars, imported or domestic. So chances are we'll have just what you need right when you need it. If we don't, we can usually get it for you overnight.

And NAPA brand parts are made to exacting standards of quality. By the top

manufacturers in the automotive industry. In fact, many NAPA parts are actually better than the original equipment parts they replace.

**When you go with
NAPA, you go
with confidence.**

Each and every NAPA brand part is backed by the NAPA National Warranty Program—the most extensive parts warranty program available. If

you ever have trouble with a NAPA brand part, just return it to any participating NAPA

AUTO PARTS store, and we'll honor the manufacturer's

warranty. Many parts are even covered for the life of your car.

**Call 1-800-LET-NAPA
and find us fast.**

There are more than 6500 NAPA AUTO PARTS stores. And you can find the nearest by calling our toll-free number. Any-

where in the country. Anytime of day. Or simply look in the Yellow Pages. So when you need parts for your imported car, don't make it a big adventure. Turn to NAPA instead.

For a big advantage.

**All the right parts in
all the right places.™**



CAR CLINIC

(Continued from page 20)

that the tire was rubbing against the chassis. Sam took his complaint to Chrysler and was told: "The tire hitting the chassis couldn't cause tire

wear. If it upsets you, ease off on the steering wheel when making hard U-turns." That's when Sam turned to Car Clinic.

My reply to Sam mentioned that I had not run into the problem and that those I spoke with at Chrysler dis-

avowed knowledge of the condition.

A few days after the August issue came out, dozens of letters hit my office confirming that there is a problem and that Chrysler has known about it for some time. David McNamara of Lima, Ohio, was good enough to send me a letter dated October 28, 1985, that he had gotten from D. M. Benes of Chrysler Corp. which states:

"Unfortunately, Chrysler Corp. does not have a correction available for the condition that you have described. Apparently, the tire touches the transmission only when the wheel is turned completely to the left, quite probably only in tight parking situations."

Mr. Benes's statement about the tire touching the transmission refers to the fact that the tire of David's car—a 1984 Turismo—rubs against the transmission cover plate.

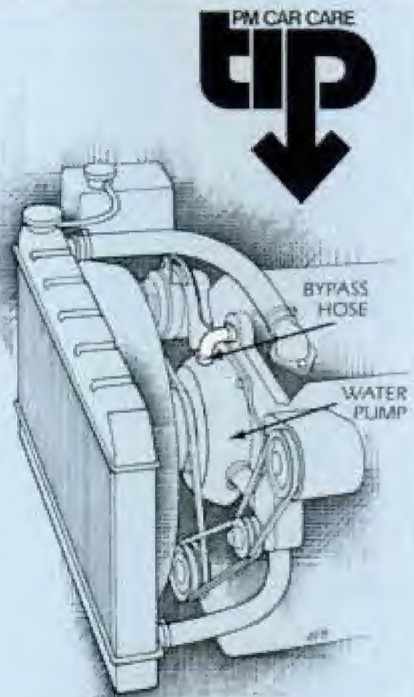
R. McGrey of Warwick, Rhode Island, has a similar situation with his '87 LeBaron GTS. The left-front tire of his car rubs against the lower spring mount if the tire is inflated to 24 psi or more. He was advised to keep tire pressure at 22 psi.

It seems, then, as if Chrysler has had an on-going problem of insufficient clearance between the left-front tire and chassis components for some time. All Sam and others can do is compensate for the absence of steering

Not To Be Bypassed

"Oh no—not the water pump," I said to myself as I checked under the hood. It sure looked as if coolant were gushing out of the pump, but I couldn't tell for sure. It was dark and my vision was blocked by billows of steam in the cool evening air.

Next morning's light revealed my good fortune. It was only the bypass hose between the pump and engine. This hose, not found on every car, lets water circulate from the pump to the engine when the thermostat is closed. Suddenly I realized what a pickle I would have been in if that small neglected hose had let go someplace besides my own driveway. It was at that moment that I decided to put replacing it on my regular cooling system hose replacement schedule, along with the radiator top and bottom hoses and heater hoses. Why take a chance for the buck or two that a new bypass hose costs?—M.S.



To stop wasting energy, press here.

Only the Hunter Programmable Thermostat has a feature that'll help you manage your heating costs every day of the month. It's called an Energy Monitor.

At the touch of a button, it displays the amount of time your furnace has run today, yesterday, this week and last week. So you can start controlling your energy usage immediately and save up to 35% on your heating and cooling bills.

In fact, our thermostat saves so much, so quickly, it pays for itself in just a few months in most homes.

And installing one takes only a screwdriver and about 30 minutes.

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HUNTER
Thermostats

stops by avoiding hard turns or adjusting tire pressure accordingly. "Ridiculous," is the way Sam describes this "fix." I agree, but that's the way matters stand.

End Of An Era?

Suppose your car has two pretty good radial tires and two baldies. You want to drive the vehicle only several thousand miles more before trading, so you don't relish the idea of buying two expensive radials. Can you buy two inexpensive bias-ply tires and use them along with the two good radials?

"Obviously not," you say, basing your answer on what tire manufacturers have been stating since the first day radials were introduced in the early 1970s—that radial and bias-ply tires should never be mixed. But now, a research program conducted by Standards Testing Laboratories (STL) in Massillon, Ohio, indicates otherwise. An extensive series of road and dynamic laboratory tests on six tire sizes from four manufacturers leads to the following conclusion:

"No modern car can be made unstable by fitting it with any mixture of modern tires of equivalent size."

Tests which were designed to detect instability were conducted on constant circle, autocross, slalom and accident avoidance courses. Five cars of various sizes and ages were used.

Asked to comment, the National Highway Traffic Safety Administration, Tire Industry Safety Council,

and Goodyear said:

■ "Our research shows a vehicle's basic handling characteristics may be adversely affected when tires are intermixed."—NHTSA

■ "Because of safety considerations and some state laws, we do not recommend unlimited mixing and suggest that motorists consult their tire or auto service dealer."—TISC

DO YOU HAVE A CAR PROBLEM?

Just ask Mort about it. Send your question to the Car Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems that are of general interest will be discussed in the column.

■ "The results of the STL study do not warrant a change from the original position that tires of different constructions should not be mixed on the same vehicle. It was not comprehensive enough to account for all the different cars on the road today."—Goodyear

We agree. The jury's still out on this one. Even if the vehicle remains "stable", which is one of those words that means something entirely different when it's spoken by an engineer, handling (at least in our experience at the magazine) is likely to suffer. And in some places it's against the law. **FM**

SERVICE TIPS

■ Has your dealer been unable to repair a delayed 2-3 upshift with the THM 440-T4 transmission in your '84-'87 GM front-wheel-drive A- or H-body model car (Celebrity, Century, Ciera, 6000, LeSabre, Delta 88 and Bonneville)? The cause may be a leaking third clutch seal inside the transmission. A new thicker seal that's part of a repair package (part No. 8646991) is now available.

■ Here's what Toyota says you should do if a tape won't eject from the cassette deck: Reset the logic circuit by disconnecting the negative battery cable, wait 30 seconds, reconnect the battery, turn on the radio, and press the eject button. The tape will probably pop out. If not, check to see whether an object has somehow gotten inside the tape deck and is causing a jam. If this is not the case, the radio assembly should be replaced.

■ If you have a 1986-87 Ford car or light truck or a Lincoln or Mercury, take a close look at that oil dipstick. Does it have a MAX mark? This is not the mark at which the oil level should be. If it's there, the engine is 1/2 quart above normal. If there is also a FULL mark on the dipstick, that's where the oil level should stop. If there is no FULL mark, the correct level is about 1/4 in. below the MAX mark. This situation has caused confusion—that's why FoMoCo has discontinued using the MAX mark on new dipsticks.

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OLD HOUSE RESTORATION

BY BOB VILA

Restoration Wallpaper

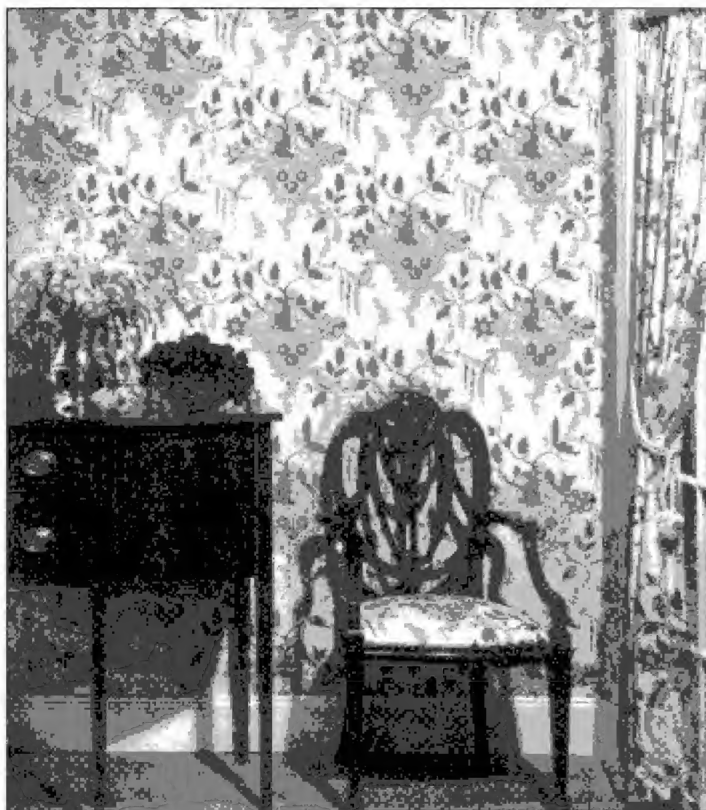
Finding—and paying for—authentic reproduction items has long been a common problem facing home restorers. Fortunately, for those interested in re-creating the original charm of an old house, things are getting better.

There's been an increased interest in restoration in the last 10 years. The fact that a number of colleges now offer programs in historic preservation and restoration reflects this. But more to the point, the marketplace has responded to the demand for authentic materials by offering a myriad of reproduction products for older homes.

Of course, it's impossible for me to discuss all the products available to help make your home a true period recreation. So this month I'll concentrate on one of the most important finishing touches of restoration work—wallpaper. Thanks to a number of suppliers who specialize in making historical reproduction or adaptation papers, it is possible to carry the authentic look of your old home through to this final detail.

Understanding wallpaper

By definition, a true reproduction paper is an exact replica of an original wallpaper document's design, scale and color. A document is an actual surviving piece of original wallpaper. Since reproduction wallpapers are made with modern materials, they are only visually like the original document. Like a reproduction, an adaptation has been modeled on an original document but is altered in some way, usually by color. Contributing Editor Bob Vila is host of public television's "This Old House."



There are good period wallpapers available for old-house restorers. Some are reproductions of documents, others—like Thibaut's Rockwood pattern (above)—are adaptations of historical design.

or design size, to reflect modern tastes. The popularity of adaptations is understandable. Current tastes do not always consider attractive the colors or pattern sizes used in the 18th or 19th century. Because of this, many manufacturers will produce a paper in the exact color of the original document, then create several others in different colors or colorways (the term used in the trade) that are sensitive to today's tastes.

There are papers that have what I call a "historical feel" or "spirit" to them. Not true reproductions or adaptations, they may have been inspired by a design found on an old lampshade, quilt or other object particular to a period.

Several factors will influence your decision when

choosing a reproduction wallpaper. The two main considerations are how much money you're willing to spend and the degree of historical authenticity or accuracy you're striving for. This can range from having custom reproduced an original document found in your old home to choosing a suitable paper from the excellent wallpaper reproduction collections available today.

Let's take a look at what these choices entail.

The ultimate—customized paper

Although it's usually only done for museums or state agencies, you can have wallpaper custom reproduced to match an existing document found in your old home. Of course, having this type of work done is a

very expensive proposition and, depending on the complexity of the design and number of colors involved, it could run you several thousand dollars a room. So you can see why it's rarely done on an individual homeowner basis.

Maybe you've found an old piece of wallpaper under layers of more modern papers or paint. If you're seriously interested in having it custom reproduced for your home (and you've got the restoration budget) try to find a piece that hasn't been affected by sunlight or water. A good place to look is in the seam, where the paper overlaps, or under a piece of molding or wood. The colors should be closer to what they originally were.

Some wallpaper suppliers will do custom hand-printed reproductions, and would be happy to take a look at your document. Based on their intimate knowledge of historical period and the marketplace, they may even decide to add it to one of their lines.

Something for everyone

The popular alternative to custom reproduction, and one that is in the financial realm of more old house owners, is to choose a reproduction or adaptation paper from those already produced today. *The Fifth Old House Catalogue* compiled by Lawrence Grow (The Main Street Press, Pittstown, NJ, 1986) is a good place to begin your search. This helpful book includes information on many wallpaper suppliers active in the restoration field today, and the kinds of papers they specialize in. (A list of some of the leading suppliers appears at the

(Please turn to page 27)

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OLD HOUSE RESTORATION

(Continued from page 24)

end of this column.) The better reproduction and adaptation papers are usually hand-printed or silk-screened. The slight paint build-up this produces (you can actually feel it with your finger tip) gives these papers a dimension—a depth of beauty and color—that looks like the block-printed originals. In this way, today's hand-printed papers can duplicate some of the finest 19th century wallpapers.

Buying a piece of hand-printed paper is like buying artwork and, of course, its price will reflect the labor and skilled workmanship that went into making the piece. Based on this, expect to pay anywhere from about \$35 to \$150 or more a roll for these top-of-the-line papers. Although you'll find some manufacturers' collections of hand-printed papers at the better wallpaper stores, most are available only through interior designers or decorators. (Most folks who go this route and have this kind of money to spend are usually advised by a professional, anyway).

Many hand-printed papers are untrimmed and usually require paste. Based on the money invested in these materials, hanging them is something that should be left to the pros.

Fortunately, some manufacturers have put reproduction wallpaper in the realm of old-house owners who have modest restoration budgets. There are some really good low-end machine printed reproductions and adaptations available today that start around \$15 a roll.

Some of these do an excellent job of reproducing 19th century machine printed papers, which were consid-

ered low-end papers then, too. Many of these machine-printed papers are pre-pasted and vinylized. You should be able to find them easily in a good wallpaper store.

Knowing what's right for your home

No matter what your restoration budget, there's an art to choosing the proper paper for your old home. This choice should be based on the period of your home, as well as a knowledge of the wallpapers commonly used in the particular room you plan to paper.

The best way to authentically restore your home is with the help of an interior designer who specializes in historic preservation. But finding a specialist like this may be difficult. It's been my experience that they're few and far between.

If you're interested in hiring this type of designer to study your home and make recommendations on restoration projects like wallpaper, your local state historic preservation office (which has various names from state to state) should be able to lead you to someone who can help.

One final note—no matter what you decide to do with your walls, if you're lucky enough to find an old wallpaper document, save some for posterity's sake. In this way, you can preserve your own little piece of the past for future generations.

PM

LEADING SUPPLIERS

- Albert Van Luit & Co., 200 Garden City Plaza, Garden City, NY 11530, (516) 741-9440.
- Bradbury & Bradbury Wallpapers, Box 155, Benicia, CA 94510, (707) 746-1900.
- Brunswick & Fils, 979 Third Ave., New York, NY 10022, (212) 838-7878.
- F. Schumacher & Co., 939 Third Ave., New York, NY 10022, (212) 644-5900.
- Richard E. Thibaut, Inc., 706 S. 21st St., Irvington, NJ 07111, (201) 399-7888.
- Sealamandre, Inc., 950 Third Ave., New York, NY 10022, (212) 361-8500.



Restoration wallpaper is also available in large murals—called scenics—like Van Luit's 8-panel *Fleur de Cathay* (shown above). Even larger scenics can be custom made.

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PHOTOGRAPHY

BY STEPHEN A. BOOTH

Sharper Images



Ricoh XR-M (left) is a super-versatile SLR. Pentax IQZoom adds zoom lens to autofocus.

If statistics can be trusted, America's love affair with photography is more torrid than ever—and shows no sign of burning out. The latest cameras and films introduced at this year's Photo Marketing

XR-M (body, \$417) is a camera you can grow with. With three autoexposure programs, all the novice need do is focus and fire. As your interest and skill increases, there's full manual control, spot light-metering, and a host of features and accessories that would make a pro proud. A built-in, 3-frames-per-sec. motor drive, and automatic back-light control, should appeal to rookies and vets alike.



Innovative flash for Olympus OM-4T syncs to any shutter speed.

Assn. show should stoke the fires hotter. Our criteria for the top photo picks here are simple. The product either demonstrates imaginative innovation, or it does the job better than its predecessors, or it makes it easier to capture better images. Some of our selections, as you'll see, qualify under all three conditions. We think our choices also underline one reason for photography's popular success: Whether serious amateur or holiday snapshotter, there's something for everyone.

■ We always admired the Ricoh XR-P as a single-lens reflex 35mm camera with a sensible amount of automation. Now, a great camera has gotten better. The new

ity to vary the focal length of the built-in lens. Though some AF rangefinders can switch internally between standard and telephoto lens, the Pentax IQ-Zoom (\$350) is the first to boast an integral 35mm to 70mm power zoom. The viewfinder zooms with the lens, to let you see exactly the composition you want.

■ The titanium-tough body of the Olympus OM-4T is remarkable enough, but it's also capable of synchronized-flash photography at any shutter speed up to $\frac{1}{2000}$ sec. with the F280 flash. Because flash duration has been prolonged 40 times, from a peak output of 1 millisecond to 40, you're no longer limited to "slow" $\frac{1}{60}$, $\frac{1}{90}$ or $\frac{1}{125}$ -sec. shutter-synch speeds. The benefit? Daylight flash to balance natu-

■ Nothing has given amateur photography such a boost—in popularity and image quality—as autofocus, point-and-shoot 35mm rangefinder cameras. The only drawback to their simplicity has been their inabil-



Canon autofocus EOS cameras and lenses are fastest to date.

ral light, or for when action shots require fast shutter speeds.

■ Eos was the ancient Greeks' deity of dawn, but Canon's Electronic Optical System signifies a new day in electronically assisted photography. As a result, the EOS 650 (\$600) and

EOS 620 (\$800) are the fastest autofocus-SLR cameras available today.

(Turn to page 30)



Fuji and Kodak have disposable cameras and four new supersharps films (left).

LMV Tips For Better Pictures



Super Close-Ups



Subjects photographed with special "macro" lenses can be posed as close as twice the focal length of the lens, to achieve reproduction ratios of 1:1 or greater. At 1:1, the image on the negative is the same size as the subject. Many zoom lenses have a "macro" setting too. But you can shoot photomicrographs (like the praying mantis seen here) with your SLR's normal lens if you couple it to the camera with inexpensive extension bellows or tubes. Be sure that the extenders retain the autoexposure features of your lens as when normally coupled to the body.

—Armand Ensanian

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\$1⁰⁰ Rebate from Stant.

PHOTOGRAPHY

(Continued from page 28)

They also focus automatically in lower light than any other AF 35mm SLR. It's all accomplished through totally electronic communication from the highly sensitive image pickup to the central microprocessor to the super-fast focusing motors built into EOS lenses. In fact, the 300mm f/2.8 telephoto uses a super-fast, super-thin ultrasonic-ring motor. Despite their sophistication, the EOS cameras can be used for simple point-and-shoot photography.

■ The chemistry department at Photo U. is keeping up with advances in electronics and optics. There's a whole new class of films that either expand the range of photomaking opportunities, or that will record more information more accurately than their predecessors. Perhaps the biggest bang of the year is the new ISO-200 speed version of Kodak's venerable Kodachrome slide film. It joins the existing 25 and 64 formulations, and applies their low grain, high-color fidelity to low-light or fast-action situations. For black-and-white buffs, Fuji's supersharp Neopan 400 Professional (ISO 400) is finally available in the U.S. Meanwhile, Kodak's new T-Max 100 promises the quality of the older ISO-32 Panatomic-X, and the new T-Max 400 improves on fine-grain ISO-125 Plus-X.

■ It happens to everyone, though maybe one dosage is enough. It's called shutterbug remorse, and it strikes whenever that once-in-a-lifetime photo and your camera find themselves in different places at the same time. Now, you can buy yourself a reprieve at drug stores, souvenir counters or wherever film is sold. Photo rivals Fuji and Kodak have introduced disposable cameras or, in more positive terminology, rolls of color film equipped with lenses and shutters. Kodak appropriately calls its product Fling (\$7). It combines a fixed-focus, 25mm f/8 lens with 1/120-sec. shutter and 24 frames of 110-format, ISO-200 color film. Fuji's Quick Snap (\$10) has 24 shots of 35mm ISO-400 color, and a fixed 35mm f/11 lens with 1/100-sec. shutter. Both are intended for outdoors, daylight use. When you finish the roll, just bring the whole unit in for processing.

It might occur to you that the Fuji and Kodak "canister cameras" make perfect stocking-stuffers for holiday gift-giving. Just remember, when you shop, keep your eyes peeled for film expiration dates—and camera warranties that are valid in the U.S. "Gray Market" cameras and lenses aren't a bargain if you can't get warranty service. Neither is film that doesn't work.

PM



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Superconductors: Facing Reality

The assembled scientists and businesspeople stirred, the ballroom of the Washington Hilton grew silent, and President Reagan strode with characteristic vigor to the podium. After hundreds of speeches in his 7-year tenure, the president was about to break new ground by offering unprecedented political momentum to the race to manufacture high-temperature superconductors. The president went on to describe the Superconductivity Initiative, which will forge Japanese-style cooperation between American industry and government laboratories engaged in superconductor research. Seldom has the chief executive rallied behind such a vital scientific pursuit.



Hot prospect? Bell Labs scientist and superconducting ceramic tape.

But the president's timely and commercially strategic maneuverings can't mask the emerging realities facing superconductor scientists and engineers. Following frantic publicity releases and sweeping prognostications, hard realities are now beginning to

temper early dreams.

Also attending the Department of Energy conference were scientists highlighting the various roadblocks to high-temperature superconductivity. Dr. Robert White of the National Academy of Engineering reminded the audience that there is still no confirmed theory—no established atomic lattice—to explain why superconductors behave the way they do. White said that a failure to understand these superconductor fundamentals will continue to be the biggest obstacle to finding practical applications. He also made the sobering observation: "It took 20 years to develop conventional liquid nitrogen-cooled superconductors. So progress may take decades."

Dr. John Rowell of Bell Communications Research wondered about updating old technologies with the new materials.

"To make superconductors really work," Rowell said, "we have to think in totally new and inventive ways." So far, visionaries foresee levitated trains and magic carpets suspended by a perpetual flow of superconductor induced magnetism. But commercial practicalities—not blue sky hypotheses—will spark the only true advancement.

Certain technical prob-

lems are becoming more and more apparent. It's difficult to make and process thin-film ceramic superconductors only a couple microns thick.

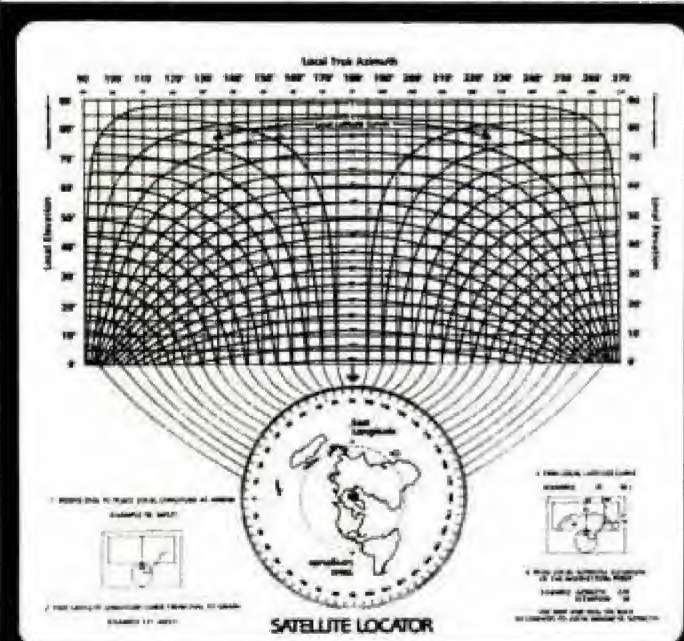
Scientists are also experiencing difficulty in arriving at the right procedure for baking this subtle compound of yttrium barium copper oxide (Y-Ba-Cu-O). Imprecise heating of the mixture can turn it into a semiconductor, or even an insulator, according to Rowell. And the recipe's oxygen content must be closely monitored if a superconductor's properties are to be maintained.

Conferees reported some progress in applying superconducting material to workable substrates—using paint processes, evaporation, sputtering and chemical vapor deposition.

But there have been difficulties in the long-term bonding of superconductors and substrates. This dilemma is expected to vex engineers for some time.

Right now, some industries are willing to absorb the huge costs of crafting adequate cryogenics to make the present-generation superconductors operate effectively. We now have superconductor-based medical diagnostic machines, particle accelerators and magnetic separators—highly specialized equipment for high-tech work. The next superconductor leap—into advanced power transmission, power generation and even fusion plasma magnets—will demand much more of superconductivity and its enabling technologies.

How long will it take to find a match between the public's need for superconductivity and the lab's ability to produce it? According to one scientist listening to President Reagan, "Prepare for the long haul." **PM**



Satellite Selector: Where In Heaven?


Satellite savants may be interested to know the azimuth/elevation angles of satellites in geosynchronous orbit. WTS Products (4308 S. Peoria, Suite 681, Tulsa, OK, 74105) has developed a handy locator that finds satellite angles from almost anywhere on Earth. It comes with a horizon-to-horizon visual representation of the full satellite arc, U.S. satellite longitude positions, a magnetic declination map and a true-to-magnetic azimuth conversion slide rule. For \$10, satellite engineers—or space hobbyists—can keep in touch with the sky.

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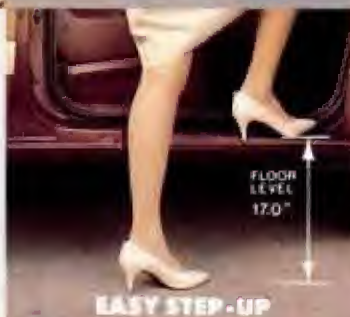
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tion of any minivan, domestic or import.[‡]

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Examine every dimension of Plymouth Voyager and you'll see why The Pride's Inside. Before You're Inside.



7/70

Division of Chrysler Motors

[†]Sticker price comparison of comparably equipped 1987 competitive minivans. ^{††}Voyager with 2.5L and manual trans. [‡]J.D. Power and Assoc., 1987 Compact Truck CSI/customer satisfaction with product quality and dealer service on 1986 models. **BUCKLE UP FOR SAFETY.**

INSIDE DETROIT

BY JIM DUNNE

Sleek 1990 Buick

Smooth and sleek. That best describes the styling of the 1990 Buick Regal 4-door sedan. The shape follows the GM dictum that says Buick will sell cars to the more conservative buyer. Leave the sporty and advanced styling to Pontiac and Olds. Still, it is difficult to say the car appears conservative. Lines have a definite aero shape. The beltline follows a gentle downward curve at the B-post, then swoops up noticeably at the rear quarter panel. This fiberglass-body prototype was put together to test public reaction. It was shown at a marketing clinic to almost 2000 carefully selected car owners. Their reaction? GM is not saying. But it would be difficult to fault this design.

Olds For 1990

This plastic model of a 4-door sedan is about as close as you will get to seeing the real Cutlass Supreme for a couple more years. Radically different from the 4-door model of last year, the new model has only two features that identify it as an Olds—the grille and the up-swept rear fender. There is strong resemblance to the new 2-door Cutlass though. The rear window glass wraps completely around the corners to cover the C-pillars. Olds will have a 3.1-liter V6 and the 2.3-liter Quad-4 as the engine lineup in this model. The overall look of the styling is in keeping with Olds' intention of building more avant garde designs that will appeal to younger buyers.

Hard To Believe

Reports that Cadillac is preparing a V12-type engine for a luxury sedan of the future just don't make much sense. Cadillac, if you

haven't noticed, is almost fully committed to front-wheel drive. (Only Cadillac's barge-size Brougham still powers through the rear wheels.) It seems impossible that a V12 could be shoehorned in a sideways position between the front wheels, when Cadillac had so much trouble squeezing in its current V8. However, word from GM is that Cadillac will be given anything it asks for so that it can compete with the top European sedans like Mercedes, BMW and Jaguar. The V12 could be the price Cadillac must pay to qualify for that



1990 Olds, still only a plastic model.

kind of competition. If the V12 makes it to production, look for its first installation in the Allante or a super-luxury 4-door sedan, as part of a 4-wheel-drive powertrain. Time: 1993?

Fins Again

Also hard to believe is that Cadillac will return fins to the rear fenders of its 1989 full-size de Ville sedans in an effort to make the cars appear larger and longer. Tiny by comparison with the giant sails that were used in the 1950s and '60s, the new fins will be about 2 in. high. In addition, Cadillac will extend the rear-end

caps of the fenders about 4 in. They will house taller taillamps.

Supercars

Chevrolet and Audi are planning supercars, but the companies are going in opposite directions. Chevrolet has a so-called "King of the Hill" Corvette under development, a super-quick version of its 2-seat sports car. Audi has something different in mind, a \$100,000 sedan that will use an Audi first—a V8 engine. The King Corvette will be powered by a Lotus-altered Chevrolet V8 that develops enormous horsepower and torque—400 of each according to insiders at Chevy engineering. Seventeen-inch wheels that carry 11-in.-wide tires will keep that power on the ground. The King is 3 in. wider than today's Corvette, but looks a little different from the front view. At the rear though, rectangular taillights and a convex shape to the end cap make the identification. Price reportedly is in the \$50,000 range. Audi's sedan is a bold attempt to leapfrog the big Mercedes and BMW's for a piece of the super prestige

sedan market. Its V8 is only 2.8 liters in displacement, but with 32 valves and double overhead cams, its output will reach 250 hp and 251 ft.-lbs. of torque. In keeping with its luxury theme, the car will only be offered with a 4-speed automatic transmission.

Air Bag Accident

If you wonder how long those safety air bags will last, this should give a clue. Recently a 13-year-old car, an Olds 98, was involved in a head-on crash. The air bags inflated just as they were designed to, and both the driver and passenger survived virtually unscathed. The survivors were unaware the older car even had the bags.

Disco Van

This prototype of the 1989 Chevrolet-Pontiac minivan showed up on GM's proving grounds recently, causing many quizzical stares. Why the gaudy, psychedelic hues on a working prototype? "We thought you'd notice it," one Chevrolet engineer replied cryptically. He seemed pleased that I captured the paint job on film. The Disco Van stands in vivid contrast to most working prototypes. They are painted solid white because white shows rust more quickly than colored paint. But since the Disco Van has a plastic body, the colored panels can't cover up rust. Front-wheel drive, space-frame chassis and V6 power are major features.

(Please turn to page 39)

Prototype Chevy Disco Van.



SEAGRAM DISTILLERS CO., N.Y., N.Y.



Have you ever seen a grown man cry?

Imported by Seagram's, Inc., New York, N.Y.

INSIDE DETROIT

(Continued from page 47)

Chrysler/AMC

Who will make the cut? Chrysler is faced with a problem that coaches in every sport have to face when it comes time to trimming their teams down to allowable limits. In Chrysler's case the question is, which cars and trucks will continue in production, which will be dropped under the new combined setup. The problem is greater than simply which vehicles are best-sellers. Final cuts may depend on what shape the factories are in, what kind of duplication the models pose, and what engines are available. Also, Chrysler has certain commitments with Renault, the major seller of AMC, to buy Renault cars or parts for a number of years. Those commitments would automatically lock certain models into staying alive. Best guesses for being cut are the Comanche pickup, Alliance, and older sedans in Chrysler's lineup. Assured of a place in the Chrysler/AMC future is the new Premier. It could take over the luxury slots in the lineup during the next 3 years as new, higher price versions are built on its chassis.

Delayed Action

Anyone who owns a car with power windows knows the irritation of having to turn the ignition back on to close a forgotten open window. You are just about to get out of the car when you notice the open window. Then you have to reinsert the ignition key, push the up button, remove the key. Now Mitsubishi has a better idea. A 30-second delay is built into the power window system of the 1988 Galant series. You can take the key out, remember the open window, and have 30 seconds to use the up button without reinserting the key. After 30 seconds, the power window system locks out, just like on other cars.

Wheels Are Important

In fact, the styling of wheels gets more attention now than at any time in the past. Because so many cars look alike, wheel design is the place manufacturers are looking to give the customer something that looks different. The 1988 Lincoln Continental premium wheel is an example. It is made by GKN of England, a company that manufactures the complete wheel. The material is cast aluminum, a popular choice for upscale cars both for its light weight and sporty appearance. GKN first paints over all the aluminum with a powder paint that leaves a high-gloss surface. (Powder paint is applied by electrically attracting a fine powder to the metal, then heating

the wheel to a temperature that melts the powder onto the metal.) The paint color is argent, a silver hue only slightly different in appearance from the raw aluminum.

Next GKN machines off the argent paint from certain parts of the wheel, bringing the surface back to the original bare aluminum and creating a slight contrast between the argent paint and the aluminum.

As a final touch, the whole wheel is then covered with a coat of clear paint, giving a shiny appearance all over, and a smooth surface that does not collect brake dust.

Jaguar Power Boost

Barely on the market 6 months, and already Jaguar has a major change in its XJ6 powerplant.

The \$40,000-plus luxury sedan gets 15 more horsepower, up to almost 200, from an increase in the compression ratio to 8.5:1 from the current 8.2:1. Early reviews of the newly designed XJ6 pointed to the mediocre performance as one of its weak points.

The added power of the new engine, plus some gear revisions, will give Jaguar's best-selling model more kick off the line.

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TOOL TEST

Power Plane Handles Tough Stuff

Most woodworkers and carpenters have used a power plane to trim wood. Now there's a power plane that not only trims wood, but it can be used to plane concrete and metal, too. The tool is the Porter-Cable abrasive plane (model No. 320) and it cuts with an abrasive sleeve rather than steel blades that are found on a standard power plane.

The plane accepts two different types of abrasive sleeves: aluminum-oxide for use on wood and tungsten-carbide for planing concrete, metal, plastics and ceramic tile. Sleeves are available in 36, 60 and 120 grit. It's powered by a



Plane uses abrasive sleeves made out of aluminum-oxide and tungsten-carbide. Use it to plane wood, concrete, ceramics and metal.

3-amp, 20,000-rpm motor and weighs less than 4 pounds and has cutting ca-

pacities of $\frac{1}{64}$ in. deep and $1\frac{13}{16}$ in. wide.

The abrasive plane is de-

signed primarily for light planing jobs such as fitting doors, planing shingles, removing paint and smoothing edges. It can cut rabbets, too. The abrasive plane is a unique tool for unique situations. It isn't intended to replace the woodcutting power plane, but to complement it.

I made several test-cuts in wood and the tool performed well. The cuts made in ceramic tile were clean, but I had to advance the plane very slowly.

The plane costs about \$140. For details, contact Porter-Cable, Box 2468, Jackson, TN 38301.

—Rosario Capotosto



To change the abrasive sleeve, first insert a locking pin to secure the arbor. Then remove the screw with a hex-key wrench.



When fitted with an aluminum-oxide sleeve, the plane trims a door bottom quickly and neatly. Note the 1-handed operation.



To plane a beveled edge, attach a shop-made wood fence to the tool's base. Cut the fence to match the desired bevel angle.



Cut a rabbet with a tungsten-carbide sleeve. Extend the sleeve beyond the tool's housing to equal the rabbet width.

Quick-Wrist Ratchet Wrenches

Although the two tools shown here look like standard wrenches, they each feature a unique ratchet mechanism for speedy tightening and loosening of nuts and bolts. The adjustable ratcheting wrench can also be locked for applying maximum torque. The Rachex is available in three sizes: 6 in. (\$15.45), 10 in. (\$24.45) and 12 in. (\$32.45).

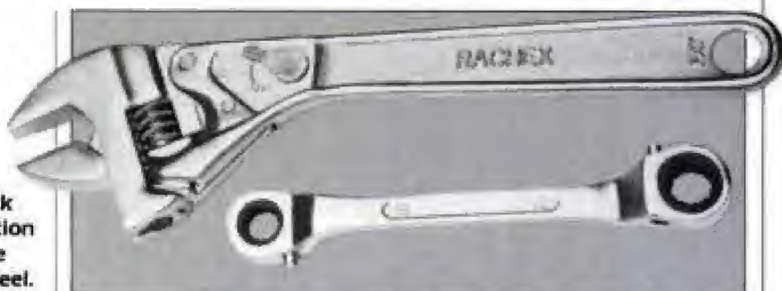
The box wrench has a switch that controls the ratcheting for tightening or loosening. A 4-piece metric set (\$28.45) covers eight sizes: 10 mm to 17 mm. Order from Continental Tools, 450 Shepard Dr., Suite 17-A, Elgin, IL 60123.

—Rosario Capotosto

The quick-action wrenches, called Rachex, are ideal for use in restricted areas. There's no need to keep taking the wrench off and putting it back on the nut. Simply work the handle back and forth and the ratchet action does the work. The tools are made of a high-grade alloy steel.



Close-up view shows that as the handle is swung to the right, the wrench's lower ratcheting jaw slides over the bolthead.



As you work the handle back and forth, the jaws will lock onto the bolthead each time you advance the wrench handle.



Each box wrench has two 12-point ratchets that are permanently sealed in the tool to prevent corrosion and fouling.



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AUDIO

BY FRANK VIZARD

Versatile Autosound

Every automobile has its own acoustic characteristics and it is this "signature" that determines how music sounds in the car. The music reproduced in one automobile might sound warm and vibrant while the same music played in another might sound dry and distant.

Sound varies between one car and another primarily because the interior dimensions and furnishings of cars vary widely. The different resonances and standing waves found in different interiors will alter the acoustic quality of an autosound system. Also affecting sound reproduction is the speaker placement.

Car manufacturers have always had the theoretical advantage when it comes to designing sound systems. They, after all, have easy access to their cars and can measure the acoustic characteristics of each one and tailor a sound system to suit. Yet, it wasn't until the automakers teamed up with audio manufacturers that this built-in advantage was exploited. GM, Ford and Chrysler paired off with Bose, JBL and Infinity, respectively, to develop autosound systems designed for a specific car. Unfortunately, all of these acoustically tailored sound systems are available in only a relatively few luxury models.

Now Blaupunkt, the West



Blaupunkt used dummy named Fritz (left) to test car acoustics.

German car audio manufacturer, has developed a way to retrofit acoustically tailored sound systems for virtually any car. The company's engineers begin this process by measuring the acoustic characteristics of numerous cars. The measurement tool is a dummy called "Fritz" equipped with microphones where human ears would normally be. Separate measurements are made for the front and rear speakers, with Fritz seated in the driver's seat and in the rear of the car. The results are integrated for an accurate picture of each sampled car's acoustical response. Then, Fritz's data is supplemented by the opinions of a panel of human listeners. The acoustic profile of each sampled car is stored inside a module which plugs into Blaupunkt's

PSA-108 Parametric Sound Amplifier. So far 83 different cars have been sampled, from Audi to Volvo and Buick to Pontiac. Modules for additional cars are promised. Each module has a list a price of \$40.

The PSA-108, equipped with the proper module, basically acts as a parametric equalizer/amplifier. Unlike the more common graphic equalizers, a parametric equalizer allows you to adjust the center frequency, bandwidth and amplitude more precisely than you could otherwise. Parametric equalizers, though, are most effective when the frequency response of the car is already known. Otherwise, more problems might be introduced into the sound system.

The PSA-108 lists for \$170. In addition to housing the module, it offers 20 watts of power per channel through each of four channels, for 80-watts.

Blaupunkt recommends that you use its car speakers with the PSA-108. But whatever brand you do choose, you should follow the company's guidelines for speaker placement strictly, since any deviation will have a pronounced effect on sound quality.

Longer Audiotape

Compact discs present something of a problem for the home taper. While some recordings fit comfortably on one 45-minute side of a 90-minute blank cassette, many do not. Some of these "extra-long" recordings might fit snugly onto the two sides of a 60-minute tape, but others leave you with an inordinate amount of unused space which at the same time is insufficient to begin taping a new disc.

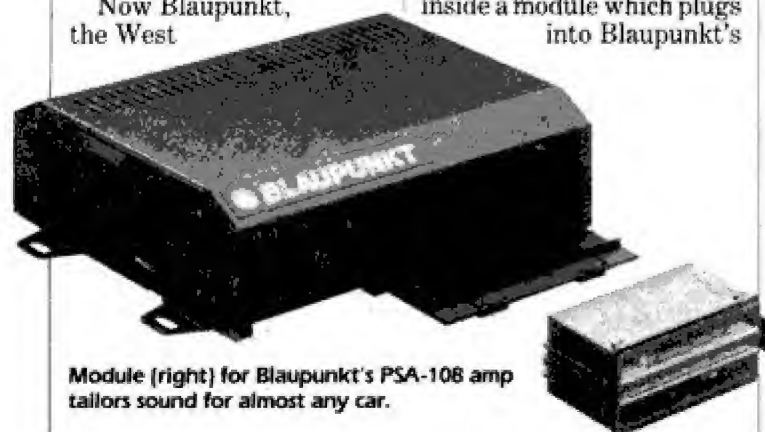
A quick look through my compact disc library illustrates the problem. Stevie Wonder's *In Square Circle* album is 49 minutes 27 seconds long. *The Best of The Band* comes in at 47:28 while Wynton Marsalis plays *Baroque Music for Trumpet* for 46:56. In each instance, I would not be able to fit each album on a single side of a C-90, and I'd have at least 10 minutes of dead-air if I used a C-60.

In the past, I would have solved this problem by recording some additional material by the same artist to fill out the remaining space on the C-60 tape. But I've never liked this solution because it seems to violate the integrity of the album already recorded. It's like finding a few extra blank pages at the end of Hemingway's *For Whom The Bell Tolls* and adding the first three chapters of *To Have And Have Not*.

Confronted with this problem in the future, I'll

(Please turn to page 44)

Denon's 100-minute cassette has extra time for recording CDs.



Module (right) for Blaupunkt's PSA-108 amp tailors sound for almost any car.

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AUDIO

(Continued from page 42)

be inclined to use Denon's new 100-minute blank cassette. This new length, says Denon, does not compromise tape performance. The tape base is still 8 microns with a coating measuring 4 microns—same as a C-90. Denon simply packs more high-energy tape into a cassette shell whose internal components prevent drag. The HD8/100 costs \$5, a price that's only 50 cents more than Denon's comparable C-90 length.

While Denon's C-100 is admirably suited to CDs under 50 minutes long, further checking of my CDs reminded me that many discs run longer. Dire Straits' *Brothers In Arms* album clocks in at 55:14 while James Galway and The Chieftains play *In Ireland* for 56:33. Any C-60 cassette will easily accommodate each disc individually, but if you like to fit two albums on one cassette, only BASF markets a 120-minute metal-tape cassette capable of hi-fi sound reproduction.

Alas, the world is not a perfect place for home tapers. The Crusaders and B.B. King perform live in London on *Royal Jam* for 67:27, a length far too long either for both sides of a C-60 or for a single side of a C-120. If Denon, however, can get 10 extra minutes onto a 90-minute cassette, then it stands to reason the company can pack several extra minutes into a C-60. The 70-minute blank tape length has to be just over the horizon.

Sound Concept

Ford's partnership with speaker maker JBL appears to have whetted the carmaker's appetite for more premium autosound systems.

The giant automaker recently unveiled its HFX Ghia Aerostar concept van boasting a 400-watt sound system. Three amplifiers rated at 40 watts per stereo channel provide power to three pairs of midrange/tweeter speaker combos mounted in the front doors, in the center of the van and in the rear. An additional 80 watts per stereo channel amp drives a pair of bass-producing subwoofers located under the middle two seats.

Both a cassette/receiver and a com-

pact disc player are mounted in the dashboard. Passengers, though, have a third sound source available to them. A portable CD player equipped with headphones is mounted on a movable console.

Ford says the sound system in the van has a sound pressure level exceeding 105 db with total harmonic distortion of less than one-tenth of 1 percent. Unfortunately, Ford also says there are no production plans for the Ghia Aerostar van.

Born In The U.S.A.

For those of you who like your electronics home-grown, be advised that dbx is putting the proud name of Newton, Massachusetts, on the front panel of its new CX1 audio/video preamplifier and BX1 power amplifier.

Manufacturing electronic home-entertainment equipment in the U.S. is like paddling into a tsunami. The wave of electronic gear produced in Japan, Korea, Taiwan and Hong Kong long ago swamped domestic producers. The economies of mass production enjoyed by Far Eastern electronic manufacturers are not available to domestic makers of home audio gear—and that fact of life is reflected in the list price of dbx's two new products. The CX1 costs \$1500 while the 400 watts-per-channel BX1 costs \$2500.

In truth, a number of high-priced home audio amplifiers have been marketed over the years by a variety of small, domestic audiophile companies. It is unusual, though, to have a product like the CX1 actually built in the U.S. Besides its source of manufacture, the CX1 is noteworthy because of the versatility it offers.

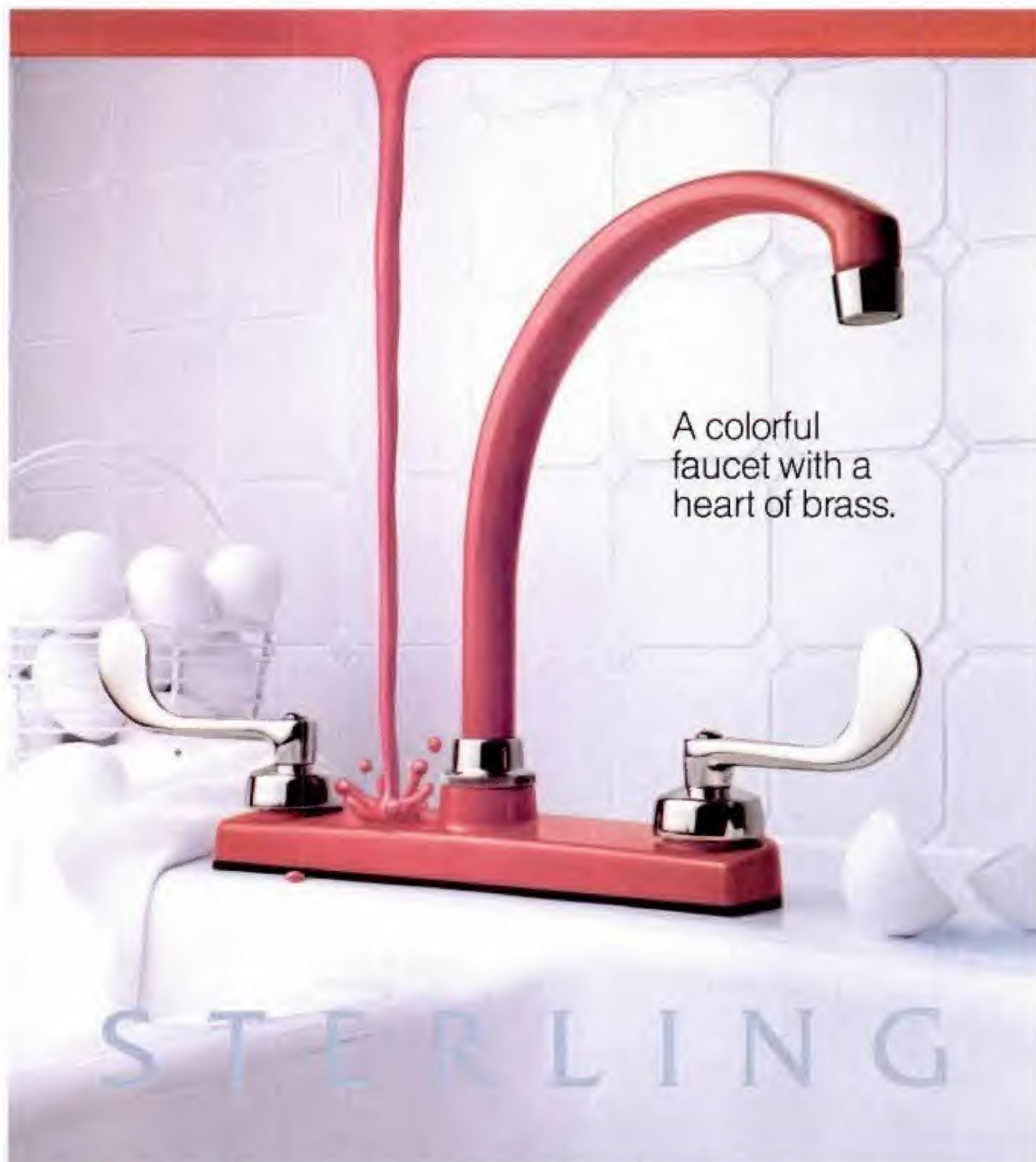
The CX1 can control up to nine separate audio and video sources, and any source can be dubbed to a connected audio or video recorder. There are also three variations of digitally processed audio ambience, as well as Dolby Surround Sound. Other notable features include a master volume control for all audio sources, a filter designed to reduce tape hiss or record scratchiness, and a soundstage control for manipulating the front left and right stereo channels.

Inside the chassis, the CX1 boasts five separately regulated power supplies. Surprisingly, no microprocessors are used in the machine, a design characteristic which dbx claims eliminates unwanted digital noise. This same philosophy means there is also no remote control. Apparently, dbx does not consider even today's fine solid-state switching methods up to snuff. All audio switching is done by mechanical switches with gold-plated connectors to avoid any possible signal degradation.

FM



CX1 preamp from dbx boasts nine source inputs, and quiet mechanical switching.



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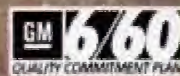
There's advanced thinking in our S-15 Jimmy, too, the kind that says a truly enjoyable sport utility is the one that's at home wherever you are.

With distinctive, sporty two-door styling, our Jimmy also offers a wide variety of plush interiors and amenities. Select a 4 X 4 model, and you can dress yours up and take it just

about anywhere.

Where all this is leading to, of course, is a trip to your nearest GMC Truck dealer. Buckle up, then get a good look at the fine selection of 1988 GMC trucks. But be warned: once you've discovered just how great one GMC truck can be, your second (or third or fourth) is just about inevitable.

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FREEWHEELING

Pontiac Grand Am SE Revisited

Our comparison test of 10 *Daily Drivers* (PM, page 71, May '87) wasn't too popular in Pontiac, Michigan. In fact, some people at Pontiac Motor Division got downright angry after reading the results of the test, in which we pitted 10 of the small family sedans against each other to determine the best buy in that market segment.

As it was, the Pontiac Grand Am SE we tested finished dead last in overall rating and ninth in our track testing. Pontiac felt that our choice of test vehicles was unfair, in that we had used a Mazda 626 GT Turbo and a Dodge Shadow with a turbocharged engine (the Mazda ranked first in the group) against the Pontiac we tested, which was normally aspirated.

The fact is, we asked for a Grand Am powered by Pontiac's turbocharged 2.0-liter 4-cylinder engine, instead of the normally aspirated 3.0-liter V6 engine in our test car. But none was available at the time of our test. The 3.0-liter engine (no longer available for '88) was rated 125 hp at 4900 rpm and 150 lbs.-ft. of torque at 2400 rpm. The turbocharged Four is rated 165 hp at 5600 rpm and 175 lbs.-ft. of torque at 4000 rpm. So naturally, with 40 more horsepower, Pontiac expected its turbocharged engine to make the Grand Am perform better.

Pontiac has since supplied us with not one, but two, Grand Am SE coupes with the 2.0-liter turbo engine. One car had a 5-speed manual transmission, the other a 3-speed automatic. Pontiac was right. The turbo-powered Grand Am performs spectacularly com-



Spinning and smoking off the line on each acceleration run was the Grand Am SE's forte.

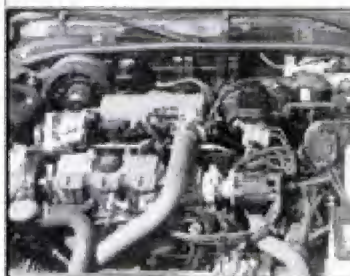
pared to the V6 car. The stick car ran the standing quarter-mile at Raceway Park in Englishtown, New Jersey, in just 15.73 seconds at 88.34 mph. The automatic car was right behind at 16.02 at 86 mph. Either car would have ranked first in acceleration.

Both Grand Ams were lots of fun to drive at the track, too, coming off the line on each acceleration run with the front tires spinning and smoking. Not only did the Grand Am look fast off the line, it *felt* fast. Those 175 lbs.-ft. of torque were enough to sock us back into the seat and keep us pinned there until the end of each run.

Out on the open road, the turbocharged engine let us drive in a very spirited manner. No longer were we hesitant to pass on 2-lane roads. There was more than enough power to cope with any road situation. Having this much power on tap under your right foot gives you a level of driving confidence you don't get

with a lesser powerplant.

Adding to the feeling of security is the SE suspension. The spring and shock rates are very firm—and meant to be so. If you're used to a soft, mushy ride, the SE is not for you. You'll think it's harsh. Yet, at higher speeds, this tautness in the suspension al-



Turbo Four pumps out 165 hp.

lows you to exert a modicum of control over the car that you won't have with a mush suspension. And the fat P215/60R14 Goodyear Eagle GT tires add to the secure feeling.

Lest you think we've found the perfect car, no we haven't. The most serious and glaring problem with

the car is torque steer. This is the tendency in a front-wheel-drive car for the front wheels to alternately spin and grip, spin and grip, when accelerating hard. The end result is that the front wheels (and the steering wheel) dart from side to side. It's an unnerving feeling and could be

dangerous in an extreme condition. With all the power from the turbo engine going through the front wheels, the SE has a bad case of it (the manual transmission was a lot worse than the automatic). But it only happens when accelerating from a dead stop under full throttle conditions, or on wet roadways. Still, it's unnerving.

Other than the torque steer, the Grand Am's negatives center on small controls in the interior. For instance, you can't use the electric seat adjustment very easily with the door closed. There's no room for your hand. For some reason, the radio's equalizer control is on the door. And the seats themselves just weren't comfortable.

Lastly, there's the price. At \$15,134, the Grand Am SE was already the most expensive car in our 10-car comparison. The turbocharged engine adds an additional \$1527. And we could manage only 15.4 mpg during our time with the cars.

Pontiac says that it builds cars for driving enthusiasts—serious driver's cars. The Grand Am SE Turbo is part way there. But acceleration isn't everything and we hope Pontiac will saw off some of the rough edges. Then it *will* be a serious driver's car.

—Joe Oldham.



Monochrome paint and aerodynamic pieces give SE a Euro-look.

CYCLES

BY NORMAN MAYERSOHN

Yamaha FZR

It's always seemed a trifle odd that the manufacturer of virtually every Grand Prix World Champion machine doesn't sell a 1-liter pure sports Superbike in this country. Sure, the Yamaha FJ1200 has been universally acknowledged as the most livable Open Class Superbike to ride day in and day out, it's breathtakingly quick in the quarter-mile and seriously fast flat out, but it lacks the full fairing bodywork and trick rectangular tube framework of the technology leaders. In short, it has a definite image deficiency.

But Japan-watchers in-the-know figured it wouldn't be long before Yamaha combined the 5-valve-per-cylinder Genesis engine technology of the FZ750 model with an aluminum frame and full-fairing skin in a liter-sized motorcycle. And those who'd been hanging onto their money in anticipation of this event were amply rewarded at last fall's Cologne motorcycle show.



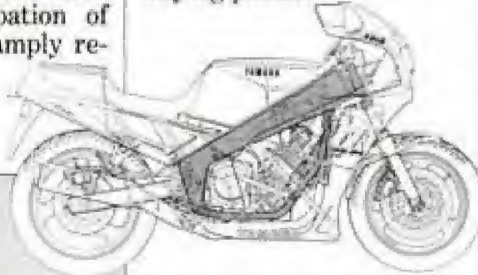
If you were among them, the time has come to reach for the savings passbook and head for your dealer.

Here's how we see the current Superbike arena: The Kawasaki Ninja 1000 is both potent and sexy, but at 590 pounds it's inexcusably porky. The Suzuki GSX-R 1100 is a relative



Paint scheme of FZR1000 attracts more attention than you'd like.

featherweight at 503 pounds, but its race-track ergonomics force the rider to grimace and bear it on the street. Honda has tossed in the towel on its V4 concept because production costs were high and owner maintenance close to impossible. Honda's replacement for the groundbreaking Interceptor, the Hurricane 1000, is a conventional inline Four with steel framework, all wrapped up in a superslick fairing that may just be a notch too far ahead of the buying public.



FZR1000's Deltabox framework is seen in the technical illustration above. The frame spars (left) snugly envelop the engine.

In contrast, the new Yamaha FZR1000 represents more than just a melding of all the best currently available technology. It takes a giant step forward with its Deltabox chassis layout—nothing else quite like it is available in this country. The two enormous frame spars, or beams, are immediately apparent when the FZR1000 is viewed side-on.

Derived from designs currently prevailing on the Grand Prix circuit, they are a substantial departure from the aluminum frames employed by competing models. While those are essentially alloy refinements of designs originally executed in steel rectangular tubing, the FZR chassis is built up from formed aluminum sheets welded together to produce a massive, extremely rigid chassis backbone. The steering head and swing arm support sections are die cast, to cut production costs.

Viewed from above, the framework is delta-shaped, and this, along with the box-shaped spars, led to the engineering department nickname. The name apparently had enough descriptive flash to please even the marketing types.

The logic behind the Deltabox design is fairly straightforward: The stiffness of a tubing chassis member is proportional to the square of the tube's diameter. Ounce for ounce, a large diameter, thin-wall tube will be stronger than a small diameter rod used in its place. The Deltabox is massive and thus gets by with thin stampings, allowing it to be both strong and lightweight. Yamaha first experimented with the Deltabox design on the 1982 OW61 race bikes and refined it over the years.

The compactness of the package necessitates a lower frame member which unbolts for engine removal. The rear frame section, which forms the seat support structure, unbolts in case it ever needs to be replaced. Altogether, the Deltabox chassis offers a high level of torsional rigidity and a low mass of just 16 kilograms (35.2 pounds).

Beyond the framework itself, the chassis is a predictably upgraded version of last year's FZ750. The rising rate Monocross rear suspension has 130 mm of travel, up 10 from the FZ750 of last year, but it has lost the rebound damping adjustments. The single shock is gas-charged and has threaded adjusters to permit tuning of the spring preload. Up front, the air-adjustable fork has 41-mm tubes, an upgrading from the 750's 39-mm stanchions—spring preload is again adjustable.

An area of major change is the braking system. Last year's internally ventilated rotors are gone, replaced by enormous 320-mm floating discs up front. The rear remains at 267 mm. The floating discs, long used in racing, give room for expansion as braking heats them up, so they are less susceptible to heat deformation and fade. Powerful 4-piston calipers do the clamping up front.

Overall, the large rotor diameter, the handsome gold-finish rotor hub and the trick calipers give a credible track-ready look to the stopping system.

Taking yet another styling cue from the racing machines, the FZR1000 uses 3-spoke wheels wrapped by low profile radial tires. The wheels are cast with hollow spokes for lightness, and the front is now a 17-inch instead of last year's 16. The tires carry a V-rating and measure 120/70VR17

up front and 160/60VR18 at the rear. Together with the wheelbase now reduced to 57.7 in. (the FZ750 was 58.5), the handling has all the right specifications for quickness of response and accurate turn-in.

When the Yamaha engineers designed the full coverage fairing they took extra steps to make it do more than just carry the bright red and white paint scheme. Its aerodynamic form has minimal weather protection for the rider, but it's full of scoops and vents to pull hot air from the engine bay. An added touch is a scoop just below windscreen level which supplies cool, fresh air to the carburetors.

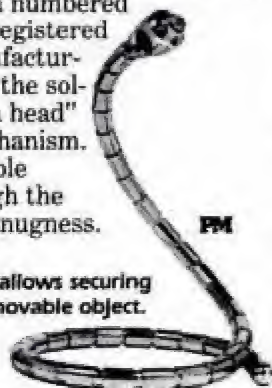
The 989-cc engine is built on the same cases as the FZ750, so the physical dimensions haven't grown. Bored out 7 mm and stroked 4.4 mm, it now has a claimed output of 130 hp. Zero to 60 times of 2.6 seconds, quarter-mile clockings of 10.5 at 130 mph, and top-end readings near 160 tend to support that. The cylinder head has been revised with larger valves at greater displacement angles, and the compression is set at 11.2:1.

At a wet weight of 525 pounds, the Yamaha is still heavier than the Suzuki GSX-R 1100, but the FZ has a considerable edge on both the 582-pound Honda Hurricane and the Ninja 1000. The flash of inspiration that creates truly great motorcycles will surely strike again and strike soon, but at the moment there is nothing to compare with the intelligent marriage of chassis and powerplant technology found in the FZR1000.

Charmed, I'm Sure

It's foolish not to lock up something as stealable as a 2-wheeler when you park. But the popular, high-quality, U-shaped locks don't always give you room to secure the bike to a properly permanent piece of real estate. The Cobralinks SL, with a standard 5-ft. reach provides a bit more lockup latitude, using case-hardened steel links over a braided aircraft cable for nearly indestructible protection. Available from the J.J. Tourek Co. (1800-18 Touhy Ave., Elk Grove, IL 60007), the lock uses a numbered circular key, registered with the manufacturer, to operate the solid-steel "cobra head" snap-lock mechanism. Sliding the cable portion through the head adjusts snugness.

Cobralinks lock allows securing a bike to an immovable object.



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Spiral Staircase Kit

Now there's an affordable way to own a beautiful spiral staircase. The Iron Shop offers easy-to-install solid oak spiral staircases in kit form. The cleverly designed kits can be assembled by any competent do-it-yourselfer—no special stair-building skills are required.

Each kit provides everything that's required for a normal installation including treads, balusters, railing, center hub components, top landing and all necessary hardware. Kits are available in three diameters—4, 5 and 6 ft.—and in three heights. The 11-riser kit (8 ft. to 8 ft., 8½ in.), 12-riser kit (8 ft., 9 in. to 9 ft., 6 in.), and 13-riser kit (9 ft., 6½ in. to 10 ft., 3½ in.) will accommodate nearly all situations. The Iron Shop will also custom-make a staircase for your specific space. The standard 11-riser kit costs about \$1475 (4 ft. dia.), \$1670 (5 ft.) and \$2725 (6 ft.).

To install a kit, first screw the base plate to the floor, insert a 1-in.-dia. threaded rod and position the oak plate over the rod (below left). Then, add the 1-piece tread/hub part (below center) and screw in place the baluster (below right). Continue in this manner to complete the staircase. For details contact The Iron Shop, Dept. PM-7, Box 128, 400 Reed Rd., Broomall, PA 19008.



A Brilliant Idea In Lighting Hardware

Here's a clever new device that makes it easier than ever to install a hanging light fixture. Called the Wire Light (\$15), it allows you to connect and disconnect a lighting fixture from the ceiling with a twist of the wrist. The 2-piece device consists of a mounting plate and a mating jack plate. Wire the mounting plate directly to the ceiling-mounted electrical box. It fits nearly all 4-in.-dia. junction boxes. Then, wire the lighting fixture to the jack. To install the light and make the electrical connection, simply push the jack into the mounting plate and give it a twist. To remove the fixture for cleaning, maintenance or to paint the ceiling, simply untwist the jack. Contact The Wiremold Co., 60 Woodlawn St., West Hartford, CT 06110. **PM**

An Elegant Door Prize

As the popularity of French doors continues to grow, Wing Industries introduces a unique interior door that features beveled glass. The door has a single sheet of tempered glass that's divided into 18 sections (lites) by V-shaped grooves. The ⅜-in.-wide grooves are cut in one side of the glass to create a beveled glass look. The lack of muntins and mullions give the door a clean, contemporary look.

The door, called La Door, is constructed of 1½-in.-thick clear ponderosa pine that comes ready for paint or stain. It's available in four standard widths: 24 in. (\$200), 30 in. (\$220), 32 in. (\$240) and 36 in. (\$260). All the doors are a standard 80 in. tall. La Door is sold through home centers. For details, contact Wing Industries, Box 38347, Dallas, TX 75238. Or, call toll-free (800) 341-WING.





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PRODUCT WARNING

Reports have been received from the field where the combination of a Smith & Wesson L-frame .357 Magnum revolver and some .357 Magnum ammunition has resulted in unacceptable cylinder binding. L-frame revolvers bear model numbers 581, 586, 681, 686 or 581-1, 586-1, 681-1, 686-1, 686CS-1.

Cylinder binding can cause a **failure to fire**. Mishandling a revolver while freeing the cylinder can result in **accidental discharge**.

Cylinder binding can result from a number of causes, including characteristics of an individual revolver or the use of ammunition which does not conform to industry pressure specifications or is particularly fast burning. Recent developments in ammunition manufacture emphasize the production of .357 Magnum ammunition with increased velocity and greater primer sensitivity.

Although there have been very few reported incidents of cylinder binding, in view of our concern for our customer's safety and the reliability of Smith & Wesson products in all circumstances, we issue the following warning:

IN A SITUATION WHERE A FAILURE TO FIRE CAN BE CRITICAL — SUCH AS LAW ENFORCEMENT OR PERSONAL PROTECTION — DO NOT USE .357 MAGNUM AMMUNITION WITH AN L-FRAME REVOLVER BEARING MODEL NUMBERS 581, 586, 681, 686 OR 581-1, 586-1, 681-1, 686-1, 686CS-1 WITHOUT AN "M" OVER THE MODEL NUMBER UNTIL YOU HAVE HAD THE REVOLVER MODIFIED.

Those who need to use their L-frame revolver under these conditions prior to modification can safely fire .38 Special ammunition.

Smith & Wesson has developed a modification to improve existing L-frame revolvers. This improvement enables them to fire all .357 Magnum ammunition, currently being manufactured to industry specification, without cylinder binding. Shipments of L-frame revolvers from our factory after August 21, 1987 already include this improvement.

You can check if your revolver includes this improvement by looking at the left side of the frame when the cylinder is fully open. If your revolver has been stamped either with a "2" or higher number after the basic three-digit model number or with an "M"

above the model number, your revolver includes this improvement and does not need modification. If your revolver bears the model number 581, 586, 681, 686 or 581-1, 586-1, 681-1, 686-1, 686CS-1 without an "M" over the model number, it does not include this improvement and you should have your revolver modified.

Smith & Wesson will modify your L-frame revolver free of charge to eliminate the possibility of cylinder binding with .357 Magnum ammunition. Law enforcement agencies wishing to arrange for modification of L-frame revolvers should call the special toll-free number, 800-458-8469 (except callers from Massachusetts, who should call collect to 413-734-8244). Other users should send their revolvers to a Smith & Wesson Warranty Service Center, specifying "L-frame Improvement Program" and enclosing their name and return address.

If you need to obtain the name and address of your nearest Smith & Wesson Warranty Service Center, please call the special toll free number set up for the L-frame Improvement Program. This number, available Monday through Friday between 9:00 a.m. and 6:00 p.m. Eastern time, is 800-458-8469 (except for callers from Massachusetts, where it is a collect call to 413-734-8244).

One of the modifications to improve the L-frame revolver is the installation of a new hammer nose. This obsolesces all old L-frame hammer noses (part numbers 4702 and 7513) and all old L-frame hammer assemblies (part numbers 3366, 3378, 3380, 3382, 3391, 4722, 4723, 4726 and 4728) in field parts inventories. Superseded parts should never be fitted into a modified revolver as this may result in malfunction. It is essential for safety that you return these obsolete L-frame hammer noses and obsolete L-frame hammer assemblies for a free exchange to Smith & Wesson, Service Department, 2100 Roosevelt Avenue, Springfield, MA 01101. Do not return L-frame hammer-nose bushings from your spare parts inventory inasmuch as they are useable in J, N and K-frame revolvers which are not included in this Product Warning.

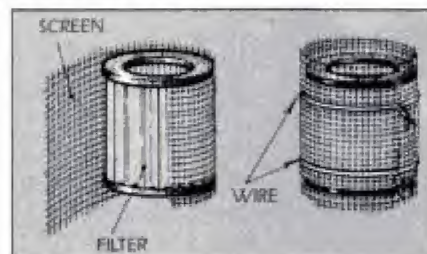
We regret any inconvenience this may cause. Smith & Wesson's first concern is the safety of its products and the protection of its customers.



Smith & Wesson
SPRINGFIELD, MA 01102-2208 USA

HINTS FROM READERS

Filter Saver

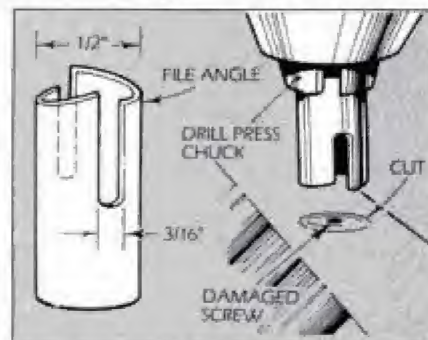


Extend the life of your shop vacuum filters by protecting them with a removable screen.

Shop vacuum filters are easily punctured by nails and other sharp debris picked up when cleaning. You can extend the life of your filter by covering it with ordinary window screen. Cut the screen a little longer than the circumference of the filter and slightly wider than the height. Wrap this around the filter and secure it with two wire bands as shown. To clean the filter simply remove the screen.—*Robert R. McKay*

Removing Broken Screws

Embedded wood screws with broken heads can be removed by using a thin-wall plug cutter to cut a circle around the screw. Then, chip away the wood inside the cut and remove the screw with pliers. The hole can be filled with a wood plug or wood filler. If you don't have a plug cutter, you can make one for use in a drill press from a 2 in. length of steel tubing. Drill holes (about $\frac{3}{16}$ in. dia. for $\frac{1}{2}$ -in. tubing) through opposite sides of the tube. Use a hacksaw to convert these holes to slots. Next, file the slotted end to produce two teeth as shown in the drawing. Slightly bending one tooth out and the other in will help prevent binding.—*Walter E. Burton*



A plug cutter can aid in removing broken or embedded screws. Make your own out of $\frac{1}{2}$ -in.-dia. steel tubing as shown above.

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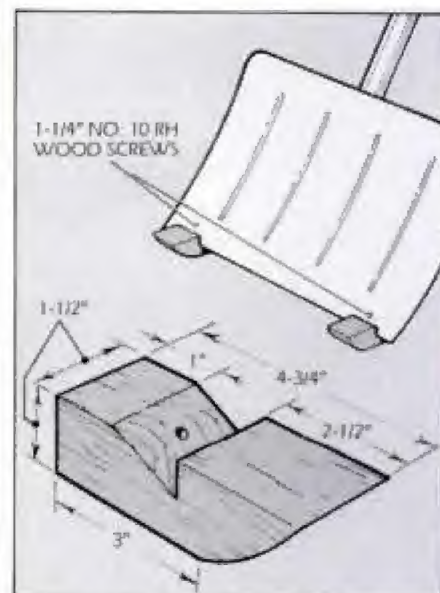
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HINTS FROM READERS

Snow Shovel Guide

Snow shovels work fine when used on concrete or asphalt driveways. But if your driveway is gravel or limestone like ours, you'll find that you scrape away the surface as you shovel. You can solve the problem by keeping the blade edge about 3/4 in. off the ground. Simply cut two hardwood runners with rounded front ends and notch them to accept the blade as shown in the drawing. Then attach the runners to the snow shovel with wood screws.

—Ed Krzysik



Unstaining Concrete

Here's a method for removing oil stains on concrete. First, wipe up any surplus oil and then wet the area with a solvent such as paint thinner. Next, spread a 1/4-in. layer of cat litter over the area. Use a board to compress the litter and provide better contact with the concrete. In a few days, you'll find the stain absorbed. The cat litter will be dry and can be swept up and reused several times.

—Walter Loewen

Save That Garden Hose

Time, again, to start winterizing chores. It's tempting to just discard some things at the end of the outdoor season, like worn, leaky garden hose. Save it! One way of recycling it comes in the spring. Run wire through pieces of it to use with stakes for supporting newly planted saplings.

—Frank Arianna



Pure Joy

(And we'll deliver...tomorrow morning)*

Imagine a superbly crafted electronic instrument, powerful enough to protect against traffic radar, miniaturized enough to slip into a shirt pocket, beautiful enough to win an international design award – and advanced enough, thanks to its sophisticated Rashid-rejection circuitry, to obsolete the detectors of every other maker.

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Money
MAY 1987

Best Anywhere

Money magazine, May 1987, listed 99 Things That Americans Make Best. "All of these widely available U.S. made goods...are clearly superior to their overseas competitors, over-whelmingly dominate their markets or are so outstanding or novel that they have no well-known international counterpart."

This select list included PASSPORT.

PASSPORT has exactly what the discerning driver seeks: superheterodyne performance with complete Rashid rejection. On duty, it maintains a commendably low profile, only 0.75 inch tall. It's about the size of a cassette tape.

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Others may put it differently. In April, *Car and Driver* tested nine of the latest radar detectors. Once again PASSPORT was rated highest. These magazine experts said, "At \$295 direct from the factory, it's the most expensive piece of electronic protection in the group, but it's worth every nickel in roadgoing peace of mind."

This good reputation keeps getting better. In June, the *Roundel* ranked PASSPORT first in a comparison of 14 detectors, saying, "It remains the State of the Art, a true quality product, American ingenuity at its best."

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— Chuck Yeager

A maintenance-free Delco battery and money back — that's a deal worth charging down to your retailer's for.

Buy a top-quality Delco Freedom or Dura Power 50, 60, 72 or Voyager battery between October 18 and December 19, 1987, and you get a \$5.00 rebate. Choose a 40-series battery and a \$2.00 rebate is yours.

Your AC-Delco retailer has rebate coupons and details. Call 1-800-AC-DELCO for the retailer nearest you.

While you're there, ask about the manufacturer's expressed limited nationwide warranty that applies to all batteries.

All requests must be received by December 31, 1987. So shop soon and get charging with AC-Delco.



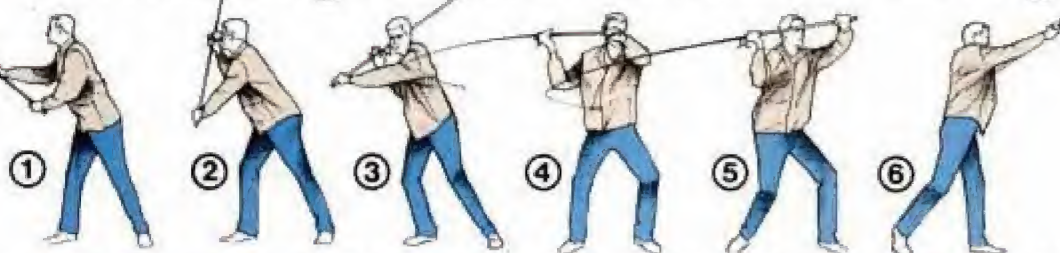
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OUTDOORS

BY JOE SKORUPA

Surfcasting With A Home-Run Swing



Power-pendulum swing is the key to longcasting. Back to water (1), swing sinker forward, then back over head (2), then begin sidearm

swing (3). As feet and torso pivot (4), transfer weight to left foot for final overhand motion (5), then hold for the follow through (6).

Ron Arra no longer plays minor-league baseball, but he's still a power hitter. In 1985, the 42-year-old Arra hit one 737 ft. 11 in. He didn't use a Louisville Slugger and didn't crush a sphere of hard rawhide.

gantuan casts, I decided to take a closer look at the growing sport. Stren, as fishermen know, is a monofilament fishing line made by DuPont and the current sponsor of the longcasting tournament trail.

I traveled to the Cape Cod Town of East Sandwich, Massachusetts, Arra's home. There, Arra, an architectural woodwork contractor, attempted to teach me the key to longcasting—the power-pendulum swing.

The longcasting swing is truly an impressive athletic feat. It's a complex, 270°

swing that sends the sinker screaming off the rod in a high vector that travels a distance greater than the length of two football fields. Not surprisingly, it's not easy to learn. But after a morning of embarrassing misfires, I was able to improve my casting distance by more than 100 ft.

Arra, a Stren staff pro, is a patient teacher. He showed me how the cast is started with your back to the water, weight on right foot, and rod angled to swing the sinker forward. The next sequence is accomplished by tilting the rod back and swinging the sinker over your head. This back-and-forth pendulum motion flexes the rod and loads it with tension.

When the rod is fully

loaded, you begin pivoting your hips, transferring weight to your left foot, and whipping the rod around in a baseball-like swing. Finally, as the sinker follows behind, you finish with an overhand casting motion, releasing the line when the rod is pointing skyward at about 45°.

Timing and technique, though vital, are only half the story. Proper equipment is the other half. Arra uses about 20 yards of 50-pound line, as a shock leader, tied onto 300 yards of 12-pound line. He uses an 11½-ft. Zziplex rod, made in England, but beginners can use any whippy surf-casting rod with a limber tip.

Arra also uses a bait-casting reel with a thumb flange spool, and he modifies it by removing the level-wind mechanism. Beginners, however, can use a spinning reel with level-wind still attached.

Speaking from experience, considerable distance

is gained by using as many of these techniques as you can comfortably handle. And it's well worth the effort, because longer casts allow you to explore more water and increase your chances of catching fish.

Another reason to give longcasting a try is the exhilarating experience of whipping a sinker out of sight with a home-run swing. After a while you might find yourself, like Ron Arra, swinging as much for world records as for fish.

Dream Machine

There's a special feeling about driving a customized vehicle. So it's not surprising that outdoorsmen have been personalizing their rigs for years.

Now Chevrolet has introduced a special option package that transforms a basic Suburban into a custom rig ideally suited for hunters and fishermen.

(Please turn to page 82)



Ron Arra, U.S. record holder, uses more technique than strength to cast 700 ft.

But if he'd been standing on home plate, he'd have put it out of any major-league stadium in the country.

What Arra was using was an 11½-ft. graphite fishing rod, and what he sent flying was a 5¼-ounce teardrop lead sinker.

Arra is one of the foremost practitioners of longcasting, a recognized tournament sport in several countries around the world. His 1985 cast set a U.S. record that still stands. Though he recently lost the national championship to Lou McEachern, of Beaumont, Texas, Arra is a 3-time former champ.

After witnessing the 1987 Stren Longcasting National Tournament, in Kalispell, Montana, and being impressed by the gar-



New Suburban has option packages for hunters and fishermen.

Dodge Power Ram 50 Sports Cab



It beats the compe

Introducing the Dodge Power Ram 50 Sports Cab. The new extended cab that beats Nissan, Toyota and Mazda at their own game. Our hard-chargin' family of import trucks has a new addition. Introducing the Dodge Power Ram 50 Sports Cab. The extended cab import pickup built to handle just about anything you want to put away. Including its competition.*

The most room up front. When it comes to inside moves, Power Ram 50 Sports Cab is the leader of the pack. With more front-seat passenger



Dodge Ram 50 Sports Cab

*Based on 1987 import pickup trucks. Always use proper tie-down technique. Always wear your seat belt. ©1987 Dodge Ram Trucks, Inc.



room than any leading import extended cab. We don't skimp on comfort either. So we include cloth bucket seats. Full carpeting. An adjustable steering column. And tinted glass. All standard.

The biggest payload. Our Sports Cab beats up the competition in the cargo department, too. We give you a massive 1,650 lb. payload. For a standard carrying capacity none of these other import 4x4's can even hold a candle to.

The most power. Power Ram 50 Sports Cab's 2.6 liter powerhouse has the most standard torque to take you to extremes. No other Japanese pickup

going has a bigger standard engine. All this muscle is hooked up to a rugged 5-speed gearbox and a 2-speed transfer case. And mounted over big 15-inch tires and wheels.

The new Dodge Power Ram 50 Sports Cab. When you're ready to really put it all behind you, just stop by your Dodge dealer. And see how our extended cab pickup beats the competition. Inside. And out.

*All comparisons are to base 1987 models (1988 competitive data incomplete at time of printing).

Dodge Import Trucks. We're going places.

BUCKLE UP FOR SAFETY

DIVISION OF CHRYSLER MOTORS



OUTDOORS

(Continued from page 59)

Powered by a 5.0-liter, 305-cu.-in. engine, this sure-footed 4x4 Outdoorsman has front brush guards with fog lamps, roof rack, rear-door ladder, outside spare-tire mount, loading lights and more.

One version of the Outdoorsman, specifically designed for hunters comes with locking storage compartments for rifles, shotguns and bows.

The fishing-option Outdoorsman package includes waterproof, segmented, heavy plastic compartments

along one side of the cargo area. On the other side are two storage units.

Suggested retail price for a pre-customized Suburban is \$13,512.

Boats And Speed

Two things are well known about speed. One is that it's a super adrenalin rush. The other is that it kills.

World powerboat racing suffered 21 deaths in the past 4 years in three of its fastest classes and several bad crashes have occurred this year.

In June, four racers barrel-rolled on Lake Pontchartrain, in New Orleans, during a single offshore race.

But this event, rather than being tragic, signaled the dawn of a new age. A new driver safety system was deployed in the boat that crashed worst and no one was killed.

The boat, *American Dream*, carrying Peter Hidalgo and David Marcus, barrel-rolled and slid upside down at 60 mph for 30 ft. before righting itself. Yet, both driver and throttleman emerged unharmed.

What saved these men from serious injury was an experimental, enclosed cockpit restraint system, which uses an F-16 fighter canopy for protection.

The three other boats that barrel-rolled also had safety systems, but not the enclosed F-16 fighter canopy and these racers suffered significant, but not permanent, injury.

Dragboaters, like offshore racers, are also becoming safety conscious. The International Hot Boat Assn. now requires a safety capsule in Top Fuel Hydro boats for the 1987 season.

A new focus on safety is a healthy and timely trend for all segments of boating, including pleasure boating. Larger motors and greater speeds are an apparent trend all over the waterways. Recently, a modified bass boat, equipped with an Evinrude XP 150-hp outboard, set a new world record by running 92.937 mph.

Shock-absorbing seats and steering columns, automatic fire extinguishers for inboards and stern drives, and crashproof windshields are just a few safety features, if made more available, that can go a long way toward keeping *pleasure* in pleasure boating.

Totally Hip Pack

Just when you think you've seen everything in the world of backpacks, an innovative company like North Face, of Berkeley, California, comes out with Totally Hip—a modular backpack made of upper and lower portions that can be used independently.

The 3-in-1 system separates into two individual units. The bottom unit is used as a fanny pack and the top as a day pack. Together they form a full-sized, conventional backpack.

Totally Hip weighs 4 pounds, has a load capacity of 2600 cu. in. and is 16 in. wide x 27 in. long. Suggested retail price is \$160. **FM**



Backpack separates into independent units.

STEP INTO THE FUTURE WITH **LOCTITE**

CORDLESS HOT MELT GLUE GUN

The LOCTITE® Cordless Hot Melt Glue Gun is simply the most convenient and versatile glue gun you will ever use.

- Never again worry about tangled power cords
- No batteries to replace or recharge
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- Works with any standard size glue stick
- Includes power base/work stand
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Caulk

Wood
Repair

General
Purpose



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Loctite Corporation
Automotive and Consumer Group
Cleveland, Ohio 44129

Save Gas, Save Engine with "POLY"

The following introduces one of the most fully tested and proven gas saving, friction-reducing engine treatments ever to reach the market!

The Secret Is "Poly"

"Poly" is short for polytetrafluoroethylene (TFE), the slipperiest substance known to man. (1981 Guinness Book of World Records). Petrolon Corporation, makers of Slick 50, invented a way to permanently bind this slippery chemical to your engine with one treatment. Just one quart of Slick 50 can reduce engine friction, increase gas mileage and horsepower and reduce engine operating temperature, causing your oil and engine to last longer. . . plus it reduces metal wear, defraying costly overhauls.

Years of Testing and Use Have Proved it True!

Slick 50 has been thoroughly tested in independent laboratories and out on the road:

The March/April 1982, p. 35 issue of "Consumer Digest" magazine stated, "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 or 3 miles per gallon."

One of the country's most respected research institutes reported applying a powerful ultrasonic cleaning process to a Slick 50 treated engine and were surprised at its permanence. "We actually expected the Petrolon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

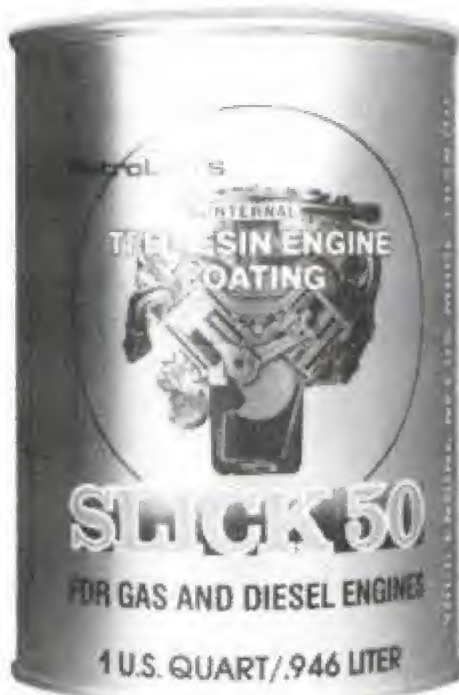
"Dune Buggies & Hot VWs" magazine April 1983 issue records the results of their one year testing of Slick 50. "We can indeed say scientifically that Slick 50 does work, and that it does reduce engine wear! . . . for the price of one treatment when compared to engine rebuild, we feel that you'd be money ahead using Slick 50."

The Federal Aviation Administration has fully accepted a similar product for aircraft—Slick 50 Aircraft Piston Engine Treatment (F.A.R. #3349). This FAA endurance test simulated 1400 hours of engine use.

The power technology laboratory at a leading southwestern university stated, "Slick 50 does increase horsepower and decreases fuel consumption in tests done at the university."

The Space Shuttle Columbia uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

Perhaps most dramatic of all is a torture test overseen by the Automotive Services Council for Pennsylvania and shown on WTVE television. Three cars with 75,000 to 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle, and the cars driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage.



There isn't room here to tell you about the dozens of other tests proving that Slick 50 is everything we say. However, if you're still skeptical, send \$2.00 to cover printing and postage costs, and we'll send you detailed test results plus actual letters from users who report how Slick 50 saved their engines and saved them money!

It's Easy to Treat Your Engine

A few minutes before oil and filter change, add the engine flush you get free with each order to clean out the engine. Let the engine idle for 5 minutes. Then drain the oil, change the filter and add the proper amount of oil, less one quart. Add one quart of Slick 50, drive for 30 minutes, and leave it in the crankcase for at least 3,000 miles. As the engine operates, the oil carries the "poly" between the parts where it is burnished into the pores of the metal.

Only One Treatment Necessary

It's permanent, so you do it only once, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8-cylinder gasoline and diesel engines.

Works with Most Oils

Slick 50 will work with all petroleum-based oils and all synthetics compatible with petroleum-based oils with the exception of graphite oils. However, once an engine is treated, you can go back to a graphite type if desired.

4 Ways Slick 50 Saves You Money

Your actual percentages may vary depending on your driving, vehicle condition, weather and geographic location, but no matter what your conditions, Slick 50 can:

1. Increase mileage
2. Increase horsepower (small economy cars and large RV's really need this)

3. Reduce operating temperatures, thus increasing the lubrication and life of the oil and engine
4. Minimize or eliminate costly overhauls by reducing engine wear

Up to 90% of the engine wear on a car can be caused by lubrication starvation cars experience when first started before the oil begins to circulate. Slick 50 can eliminate this problem for less than the cost of two tanks of gas.

Slick 50 Will Not Affect Your Warranty

Slick 50 is suspended in an excellent grade of petroleum oil which meets or exceeds every manufacturer's engine warranty requirements. In addition, this oil carries an American Petroleum Institute service classification SF-CC-CD.

There's No Risk with Our Money Back Guarantee

Use Slick 50 for 3000 miles. If you don't notice an improvement in engine performance, return your invoice with a short note telling why, for a prompt full refund — no questions asked.

Profit from Selling Slick 50 Yourself

Here's an opportunity to make handsome profits. Having such solid test results from major institutions make Slick 50 easier to sell than many other products. Free dealership information is sent upon request.

For purchase or further information call toll-free 1-800-525-8624, ext 11 (in California 1-800-233-9559) or send to: Progressive Energy Corporation, 255 South Bent Avenue, #B-1, Dept. PM117 San Marcos, California 92069.

Yes, I want to improve my car's performance and save my engine — rush me risk free

☐ One Slick 50 at \$39.95 + \$4.00 shipping and handling. Calif. Residents add 6% Sales Tax.

☐ Give me free shipping and handling for my order of 2 or more at \$39.95 each.

☐ Check ☐ C.O.D. ☐ Visa/MasterCard

Card # _____

Exp. Date _____

Name _____

Address _____
(Give street address if possible for UPS delivery)

City _____ State _____ Zip _____

PEC
Progressive Energy Corporation

255 South Bent Avenue, #B-1, Dept. PM117
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WIDTH LENGTH	12" to 23"	23-1/8" to 26"	26-1/8" to 29"	29-1/8" to 32"	32-1/8" to 36"	36-1/8" to 40"	40-1/8" to 44"	44-1/8" to 48"	48-1/8" to 52"	52-1/8" to 57"	57-1/8" to 62"	62-1/8" to 67"	67-1/8" to 72"	72-1/8" to 82"	82-1/8" to 92"	92-1/8" to 102"	102-1/8" to 112"	112-1/8" to 122"	122-1/8" to 132"	132-1/8" to 142"
Up to 42"	\$57.00	\$62.00	\$67.00	\$71.00	\$80.00	\$87.00	\$93.00	\$99.00	\$106.00	\$120.00	\$128.00	\$136.00	\$144.00	\$163.00	\$179.00	\$204.00	\$220.00	\$241.00	\$258.00	\$274.00
YOUR COST!	22.80	24.80	26.80	28.40	32.00	34.80	37.20	39.60	42.40	48.00	51.20	54.40	57.60	65.20	71.60	81.60	88.00	96.40	103.20	109.60
42-1/8" to 48"	\$62.00	\$67.00	\$73.00	\$78.00	\$88.00	\$95.00	\$102.00	\$109.00	\$116.00	\$132.00	\$141.00	\$150.00	\$159.00	\$178.00	\$197.00	\$223.00	\$242.00	\$264.00	\$283.00	\$301.00
YOUR COST!	24.80	26.80	29.20	31.20	35.20	38.00	40.80	43.60	46.40	52.80	56.40	60.00	63.60	71.60	78.80	89.20	96.80	105.60	113.20	120.40
48-1/8" to 54"	\$67.00	\$73.00	\$79.00	\$85.00	\$95.00	\$103.00	\$111.00	\$118.00	\$126.00	\$143.00	\$153.00	\$163.00	\$173.00	\$195.00	\$215.00	\$243.00	\$263.00	\$288.00	\$308.00	\$328.00
YOUR COST!	26.80	29.20	31.60	34.00	38.00	41.20	44.40	47.20	50.40	57.20	61.20	65.20	69.20	78.00	86.00	97.20	105.20	115.20	123.20	131.20
54-1/8" to 60"	\$72.00	\$78.00	\$85.00	\$91.00	\$102.00	\$111.00	\$119.00	\$128.00	\$137.00	\$154.00	\$165.00	\$176.00	\$187.00	\$211.00	\$232.00	\$263.00	\$285.00	\$311.00	\$333.00	\$355.00
YOUR COST!	28.20	31.20	34.00	36.40	40.80	44.40	47.00	51.20	54.80	61.60	66.00	70.40	74.80	84.40	92.80	105.20	114.00	124.40	133.20	142.00
60-1/8" to 66"	\$77.00	\$84.00	\$91.00	\$98.00	\$110.00	\$119.00	\$128.00	\$138.00	\$147.00	\$166.00	\$177.00	\$189.00	\$201.00	\$227.00	\$250.00	\$282.00	\$306.00	\$334.00	\$358.00	\$382.00
YOUR COST!	30.80	33.60	36.40	39.20	44.00	47.60	51.20	55.20	58.80	66.40	70.80	75.60	80.40	90.80	100.00	112.80	122.40	133.60	143.20	152.80
66-1/8" to 72"	\$82.00	\$89.00	\$97.00	\$104.00	\$117.00	\$127.00	\$137.00	\$147.00	\$157.00	\$177.00	\$190.00	\$202.00	\$215.00	\$243.00	\$268.00	\$302.00	\$328.00	\$358.00	\$384.00	\$409.00
YOUR COST!	32.80	35.60	38.80	41.60	46.80	50.80	54.80	58.80	62.80	70.80	76.00	80.80	86.00	97.20	107.20	120.80	131.20	143.20	153.60	163.60
72-1/8" to 78"	\$87.00	\$95.00	\$103.00	\$111.00	\$125.00	\$135.00	\$146.00	\$157.00	\$168.00	\$189.00	\$202.00	\$215.00	\$229.00	\$259.00	\$286.00	\$322.00	\$349.00	\$381.00	\$409.00	\$436.00
YOUR COST!	34.80	38.00	41.20	44.40	50.00	54.00	58.40	62.80	67.20	75.60	80.80	86.00	91.60	103.60	114.40	128.80	139.60	152.40	163.60	174.40
78-1/8" to 84"	\$92.00	\$100.00	\$109.00	\$118.00	\$132.00	\$143.00	\$155.00	\$166.00	\$178.00	\$200.00	\$214.00	\$229.00	\$243.00	\$275.00	\$303.00	\$341.00	\$371.00	\$405.00	\$434.00	\$463.00
YOUR COST!	36.80	40.00	43.60	47.20	52.80	57.20	62.00	66.40	71.20	80.00	85.60	91.60	97.20	110.00	121.20	136.40	148.40	162.00	173.60	185.20
84-1/8" to 90"	\$97.00	\$106.00	\$115.00	\$124.00	\$139.00	\$152.00	\$164.00	\$176.00	\$188.00	\$211.00	\$227.00	\$242.00	\$257.00	\$291.00	\$321.00	\$361.00	\$392.00	\$428.00	\$459.00	\$490.00
YOUR COST!	38.80	42.40	46.00	49.60	55.60	60.80	65.60	70.40	75.60	84.40	90.80	96.80	102.80	116.40	128.40	144.40	156.80	171.20	183.60	196.00
90-1/8" to 96"	\$102.00	\$111.00	\$121.00	\$131.00	\$147.00	\$160.00	\$173.00	\$185.00	\$198.00	\$223.00	\$239.00	\$255.00	\$271.00	\$307.00	\$339.00	\$381.00	\$414.00	\$451.00	\$484.00	\$517.00
YOUR COST!	40.80	44.40	48.40	52.40	58.80	64.00	69.20	74.00	79.20	89.20	95.60	102.00	108.40	122.80	135.60	152.00	165.60	180.40	193.60	206.80
96-1/8" to 102"	\$107.00	\$117.00	\$127.00	\$137.00	\$154.00	\$168.00	\$181.00	\$195.00	\$209.00	\$234.00	\$251.00	\$268.00	\$285.00	\$323.00	\$357.00	\$400.00	\$435.00	\$475.00	\$510.00	
YOUR COST!	42.80	46.80	50.80	54.80	61.60	67.20	72.40	78.00	83.60	93.60	100.40	107.20	114.00	129.20	142.80	160.00	174.00	190.00	204.00	
102-1/8" to 108"	\$112.00	\$122.00	\$133.00	\$144.00	\$162.00	\$176.00	\$190.00	\$205.00	\$219.00	\$245.00	\$263.00	\$281.00	\$299.00	\$339.00	\$375.00	\$420.00	\$457.00	\$498.00	\$535.00	
YOUR COST!	44.80	48.80	53.20	57.60	64.80	70.40	76.00	82.00	87.60	98.00	105.20	112.40	119.60	135.60	150.00	168.00	182.80	199.20	214.00	
108-1/8" to 114"	\$117.00	\$128.00	\$139.00	\$150.00	\$169.00	\$184.00	\$199.00	\$214.00	\$229.00	\$257.00	\$276.00	\$295.00	\$313.00	\$355.00	\$392.00	\$440.00	\$478.00	\$522.00		
YOUR COST!	46.80	51.20	55.60	60.00	67.60	73.60	79.60	85.60	91.60	102.80	110.40	118.00	125.20	142.00	156.80	176.00	191.20	208.80		
114-1/8" to 120"	\$121.00	\$133.00	\$145.00	\$157.00	\$178.00	\$192.00	\$208.00	\$224.00	\$240.00	\$268.00	\$288.00	\$308.00	\$327.00	\$371.00	\$410.00	\$460.00	\$500.00			
YOUR COST!	48.40	53.20	58.00	62.80	70.40	76.80	83.20	89.60	96.00	107.20	115.20	123.20	130.80	148.40	164.00	184.00	200.00			
120-1/8" to 126"	\$126.00	\$139.00	\$151.00	\$164.00	\$184.00	\$200.00	\$217.00	\$233.00	\$250.00	\$279.00	\$300.00	\$321.00	\$342.00	\$387.00	\$428.00	\$479.00	\$521.00			
YOUR COST!	50.40	55.60	60.40	65.60	73.60	80.00	86.80	93.20	100.00	111.60	120.00	128.40	136.80	154.80	171.20	191.60	208.40			

To Order By Mail Send Check or Money Order along with Quantity of each size (width 1st, then height), in inches using a metal ruler! State if Inside or Outside mount. Color name & number such as Rose #068. Free UPS shipping in 48 States up 85" wide. Larger blinds shipped motor freight for \$35 flat rate-any quantity!

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Quality Window Fashions

MEASURING FOR A PERFECT FIT!

INSIDE MOUNT: To mount Bali Blinds inside your window frame, your window should be at least 1" deep. (Note example as shown on right.)

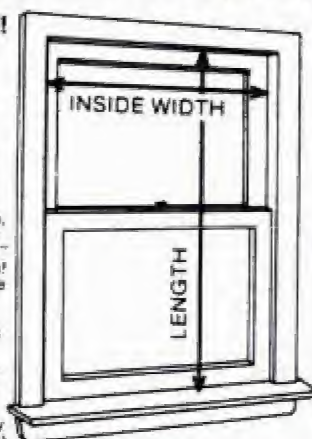
1. Measure the opening **width** in three places: Top, Middle, and Bottom. The narrowest of these dimensions will be your **width**.
2. Measure the opening **length** from the top to the sill. Specify **INSIDE MOUNT** on order form!

OUTSIDE MOUNT: To mount Bali Blinds on your wall or molding.

1. Measure the exact **width** and add desired overlap, such as molding width to inside width. If there is no molding, recommended overlap is at least 1 1/2" per side. Specify **OUTSIDE MOUNT** on order form!
2. Measure the exact **length** from at least 1 1/2" above soffit to sill. For windows without sills add 1 1/2" more. **NOTE:** If your window frame projects out from the wall, you may need to specify extension brackets so the blinds will clear the frame!

CONTROL LOCATIONS: Standard control locations will be provided unless indicated otherwise! (Wand Tilt on left, Lift Cord on right.)

CAUTION: Do not take any deductions!! The factory will make the allowances to ensure proper fit!



PM TECH UPDATE

NOVEMBER 1987



AIR FORCE ILLUSTRATION

New Wings For The President

Wichita, Kansas—When former President Ronald Reagan flies westward to his home state of California on January 21, 1989, he'll ride aboard a brand new Air Force One.

Two Boeing 747-200Bs were recently selected to serve into the next century as the plane for presidents. They were flown from Seattle, Washington, to Wichita, where they'll be outfitted and painted. The two jumbo jets—scheduled for delivery in November 1988 and May

American presidents into the 21st century will fly aboard a gleaming Boeing 747-200B.

1989—will replace the two Boeing 707-320Cs that have flown six presidents since October 1962. The second 707 was added to the executive fleet in 1972.

The 747 thus enters an elite stable of historic aircraft. Theodore Roosevelt was the first president to fly, FDR the first president to fly regularly, making the first transoceanic flight by an American chief executive aboard a Boeing 314 Flying Boat. Roosevelt flew domestically aboard a Douglas C-54 Skymaster dubbed *Sacred Cow*, and his peripatetic First Lady flew in a converted B-24 bomber called the *Guess Where II*. President Harry Truman's plane was a DC-6 named *Independence* after his hometown in Mis-

souri, and Dwight Eisenhower, the only licensed pilot to occupy the White House, flew aboard a Lockheed Constellation Model 749 named *Columbine II*.

The presidents' new airplane will be as functional—if not more grand—than its predecessors. Air Force spokesmen decline to divulge details about Air Force One for obvious security concerns, but they indicate the 747 will be powered conventionally by four General Electric CF6-80C2B1 engines, each offering 56,750 pounds of thrust. The aircraft will have an unrefueled range of more than 6000 miles. Self-sufficiency in remote regions will be enhanced by a second Garrett auxiliary power unit in the

tail and self-contained air stairs that can be deployed from the plane's lower deck.

Nearly 4000 sq. ft. of interior space will be taken up by the president's stateroom, personal office, conference room and lavatory. Two galleys will serve the remaining 70 passengers and 23 crewmembers, which include the ground personnel that travel with the plane. An emergency-treatment medical facility is also onboard, along with sophisticated communications equipment, including secure voice terminals and cryptographic equipment.

These and other Air Force One electronic components are state-of-the-art—appropriate for a plane that will carry our nation's chief executives into the 21st century.

Editor: Tim Cole
Contributors: Jennifer Gosselin,
Mike Fillon, Nick Nichols, Josh
Eppinger, Chris Davis, Jim Peterson

Signaling Submarines

Sunnyvale, California—The problem is as old as the nuclear Navy: How do you communicate with submerged submarines? Lockheed may have found an answer with the Submarine Laser Communication System. Its electro/optical antenna (pictured) adjusts the focal length of a signal-carrying laser emanating from a satellite in High Earth Orbit. Focusing the laser allows for optimum optical signal transmission. It will permit secure, real-time communications links between ground-based commanders and subs at operational depths.



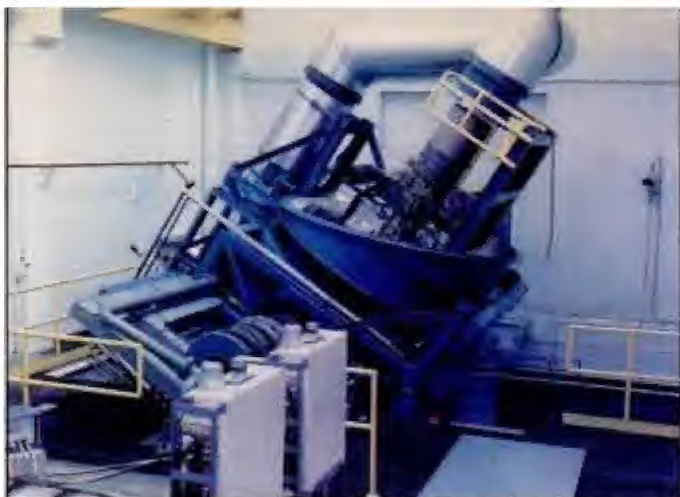
Lockheed laser/optics antenna.

Scanning The Brain With Light

London, England—The technology developed by scientists at University College Hospital may one day help doctors limit brain damage among infants born prematurely. It consists of a scanning device that uses infrared light and ultrasensitive sensors to measure the flow of oxygenated blood in the brain. When the light is directed toward the skull, all but a minute fraction of the light is blocked. The amount of light that gets through is a function of how much oxygenated blood is present in the brain. The infrared sensors are able to detect these traces of remaining light, which helps determine how much blood is reaching the brain and whether corrective measures—even surgery—might be needed. Unlike X-rays or other medical imaging devices, the infrared scanner can be used continuously, and may have an application in correcting ailments involving muscles, kidneys and hearts. Doctors also predict a use in the emergency room to determine the extent of head injuries.



Scanner that measures the flow of oxygenated blood in the brain.



Tilt-Rotor's Allison T406 turbine locked in new tilting test stand.

Tilt-Rotor Attitude Check

Indianapolis, Indiana—The engines aboard the V-22 Osprey tilt-rotor will move through a 205° arc as the aircraft makes the transition from vertical to horizontal flight.

This unusual requirement will place extraordinary strains on lubrication, electronics and fuel delivery. To make sure the Osprey's twin turbines are up to the task, engineers at General Motors' Allison Gas Turbine Division have developed a tilting test stand to make sure each T406 rolling off the assembly line meets quality control.

All attachments to the test stand move with the engine—fuel, lube, water, yards of instrument wiring, an energy-absorbing water brake, even the multi-angled duct work that channels exhaust outdoors. The 6000-shaft-hp T406s will be mounted in the Osprey's wingtip nacelles, which will swing from vertical to horizontal. The engines will be mated to special transmissions that will drive two, 3-bladed airfoils. When the nacelles are vertical, the airfoils act like high-lift helicopter blades, giving Osprey the ability to take off in an extremely short area and to hover. As the nacelles are tilted horizontally, Osprey can fly from 0 to 300 mph in a matter of seconds, assuming the speed and range of fixed-wing aircraft. The Osprey will serve the Army and Marines in infantry transport and armed assault roles. The tilt-rotor will also join the Navy to conduct antisubmarine warfare.

Materials Handling 1995

New composites used in a variety of high-tech industries often require substantial revision in conventional manufacturing theories. Northrop Corp.'s new nickel-mold spray gun is a case in point. The device sprays metal flakes on a mold used to form the composite parts for the vertical fin tip on the F/A-18 Hornet strike fighter. The spraying operation repairs the mold so it can be used over and over again without costly, time-consuming replacement.

The spray-gun innovation joins the many new plastics currently being introduced to aviation. At Bell Textron, engineers are creating plastic panels that will eliminate 40 building steps.

New manufacturing techniques also require new protective clothing. One-piece suits integrating coveralls, gloves, eye protection, a hard hat and breathing apparatus are used to help put today's composite aircraft on the flight lines.



Northrop's nickel-mold spray.

Yesterday's Engine Tomorrow

Hampton, Virginia—A 19th century Scottish minister named Robert Stirling is credited with the concept. Take a "working gas" like hydrogen and run it through a rapid heating-and-cooling cycle to drive a piston. The process, involving "external" combustion, ultimately transmits power to an output shaft. The Stirling engine requires very little air, making it an ideal powerplant in short- to medium-duration submarines. It appeared most recently in the French commercial submersible



AIR FORCE PHOTO



Langley's Stirling-powered van, (left), and Stirling exposed, (right).

Saga I, and is being considered for a new Swedish attack sub being designed for the Australian navy.

But the Stirling's most promising debut came recently in a standard U.S. Air Force transportation van at

Langley AFB. The Stirling-equipped vehicle operated more than 1000 hours and ran on a variegated diet of diesel fuel, unleaded gasoline or aviation JP-4. The engine has no carburetor, sparkplugs, catalytic converter or muf-

fler, so maintenance is low. Air Force testers also point out the engine's cool exhaust temperatures, which may have an impact on the battlefield. Low thermal signatures help vehicles mask defensive positions.

Lasers At Work



NORTHROP PHOTO

Northrop's 5-axis titanium cutting laser.

New York, New York—Lasers are making the slow but steady transition from laboratory novelty to industrial tool. And nowhere is the technology more promising than in the field of industrial composites, where new shaping and handling procedures are continually being developed. At Northrop Corp.'s Aircraft Division in Hawthorne, California, an 800-watt, 5-axis laser is learning how to work with advanced materials that are difficult to machine with conventional tools. The laser trims a titanium heat shield for fighter aircraft (pictured). Computers handle the entire operation from initial programming to final cutting.

In other developments, advancements in laser optics are beginning to make an impact on the computer and communications industries. Scientists at St. Andrews University in Scotland have just developed a laser that shatters the world record for the shortest pulse, a breakthrough that could help lasers take the place of tiny circuitry embedded on computer silicon chips. The laser pulse lasts a mere 19 femtoseconds—or 19 quadrillionths of a second. The laser beam was reflected through a series of seven high-quality mirrors. St. Andrews scientists say the quick-pulse laser could also lead to ultrafast optical logic devices, optical modulators and optical switches.

In other optics-related developments, engineers at Edinburgh's Heriot-Watt University have created a parallel digital optical circuit. While strides are being made to pack more and more circuitry onto a silicon or gallium arsenide computer chip, particularly through the use of X-ray lithography, Heriot-Watt researchers predict that practical limits in chip density

are coming soon. When computer manufacturers run out of memory space, they'll no doubt resort to laser optics.

Out on the shop-room floor, lasers are taking up the conventional tasks of bending and shaping metals in manufacturing. One of the smallest high-power commercial lasers was recently developed at the University of Technology in Leicester, England.

Weighing only 100 kilograms, the 5-kilowatt carbon-dioxide laser can be focused to very-high-power densities for rapid automated cutting, welding and heat treating. With a normal CO₂ laser, an energy pump excites CO₂ molecules.

When these molecules return to normal, they emit a specific wavelength of light. A mirrored resonator intensifies the light, which is then focused into a beam. The small size of the Leicester laser could mean a potential scale-up to 25 kilowatts, increasing the power—and the usefulness—of lasers in the workplace.



LONDON PICTURES SERVICE PHOTO

St. Andrew's quick-pulse laser.



LONDON PICTURES SERVICE PHOTO

Manipulating conventional metals with conventional lasers.

TECH UPDATE

NOVEMBER 1987

SDI's Latest Strides

Sunnyvale, California—Despite misgivings expressed



Lockheed scientists with LODE.

in certain quarters, researchers are reporting some success in creating the laser battle station of tomorrow. Scientists at Lockheed Missiles & Space Co., have developed the Large Optics Demonstration Experiment (LODE). The device shows how a laser beam can be focused. A concentrated laser is the result, which may one day have the ability to disable a boost-phase ICBM.

Laboratory Flea Flickers

Ithaca, New York—While the rest of the world devises a scheme for getting rid of fleas, parasitologists at the Cornell University School of Veterinary Medicine are developing ways to propagate them in the lab to see what



A common cat stalks the common-cat flea in a Cornell lab.

makes them tick. The method consists of a double-walled glass membrane feeder resting on a stack of sieves. To substitute for animal skin, a plastic and paraffin membrane is stretched across the feeder's inner chamber. Sci-

entists add fresh, warm animal blood and the device becomes a feeding trough for thousands of fleas. Researchers have already learned that a flea can grow from an egg to an egg-laying adult in less than 2 weeks.

Flying In 1995—And Beyond

Seattle, Washington—Airline executives are finding out that they'll have to come up with some pretty attractive inducements to lure passengers in the next decade of deregulated air travel.

Boeing and Sony, with Trans Com Systems, are helping to attract passengers with a unique inflight entertainment and cabin management system for Boeing's midrange 7J7. Boeing recently postponed full-scale development of the 7J7 because of lack of orders.

But the 7J7's onboard individual 4-in. flat-panel CRT displays will be located on seat backs, allowing passengers the freedom to select such diverse entertainment alternatives as movies, television or live TV showing the flight deck during takeoff and landing. The visual system also includes seven videogames.

Multiple stereo channels are also envisioned for audio entertainment, and passengers will be able to order meals, drinks and duty-free goods. They will also be able to consult gate directories, review the status of connecting flights, or consult a moving route map.

Individual consoles will be tied to a central cabin management system designed to decrease flight attendant work load



The Boeing/Sony 7J7 entertainment system.



Airline passenger seat of tomorrow.

and increase passenger service. The computer-based device gives flight attendants instantaneous information on passenger needs, keeps a food and beverage inventory for both flight and ground crews and keeps a cabin maintenance report. Another maintenance control computer being considered for the 7J7 monitors inflight faults, determines the cause and proposes a cure. A computerized history of each aircraft is thus generated and maintained.

The heart of the Boeing/Sony collaboration will be a compact head-end unit that stows conveniently in an overhead rack or in a locker. The unit will consist of banks of 8mm videotape recorders, videogame banks, CD and audiotape reproducers and a master control panel with backup video display unit. This type of inflight fodder will no doubt be commonplace by the time the National Aerospace Plane becomes a reality.

The aircraft will have the ability to fly "transatmospheric" from Los Angeles to Tokyo in 2 hours, or, in some versions, achieve Low Earth Orbit. Passenger comfort will be critical to passenger safety aboard the NAP. Accordingly, Weber Aircraft recently sponsored a competition to devise NAP's interior accommodation. The highly molded reclining rocker is the result, pictured. It's just the kind of seat airline passengers of the 21st century will ride past Mach 25.

Para-Point chute (right) uses ram-air canopy. A Transmitter/Controller (below) is used to guide a payload to a pinpoint landing.

Pinpoint Air Drops

Pennsauken, New Jersey—Mountain climbers, exploration teams and military special forces units can now have added security in the field with an innovative servo-controlled parachute delivery system. The Para-Point consists of a ram-air canopy and rigging for the

payload, an airborne guidance unit (AGU) and a ground-based Transmitter/Control (T/C). The T/C-equipped ground controller can manually guide the parachute in for a landing, or activate Para-Point's special autopilot feature for an automatic landing.

In automatic mode, the T/C becomes a homing beacon that steers the canopy to within 200 ft. of recipients on the ground.

Some exercises call for a parachutist to carry the T/C, which is activated en route. The provisions chute is then released, which dutifully follows the Transmitter/Controller to a landing.



Herc In Surveillance Role

Marietta, Georgia—The Air Force Air Defense Initiative (ADI) will develop ways to detect, track and destroy low-level bombers and cruise missiles that have low radar cross sections. Lockheed's airborne phased-array radar antenna, being tested now aboard the C-130-derived High Technology Test Bed (HTTB), is a key element in the Air Force drive to spot penetrating aircraft. Phased-array antennas produce a radar beam that can be scanned in various directions simultaneously to track extremely small targets in ground clutter while searching for new ones. Lockheed software programs can simulate how the 45-ft. phased-array antenna's radiation pattern will be affected by wings, engine nacelles and other aircraft appendages. HTTB is also helping engineers evaluate new heads-up displays, special high-pressure hydraulics and new large-diameter props.



The phased-array radar installed on a Lockheed's C-130.

Bringing SDI Down To Earth

Washington, D.C.—Electromagnetic rail guns are being actively researched as the linchpin for the Strategic Defense Initiative. A projectile is placed between two parallel copper rails, and a direct current is sent down the rails in opposite directions. This sets up an electromagnetic field that drives the projectile forward at exponentially increasing velocity. Some planners from the U.S. Army and the Defense Projects Research Agency (DARPA) think the electromagnetic concept will work on a mobile armored platform. The advantage? An electromagnetic gun would develop more than 9000 joules of kinetic energy. Conventional ballistic arms now generate only 4500 joules.

But there are drawbacks. Skeptics say electromagnetic armor would require too much power—and would therefore weigh too much—to be of much use.



Electromagnetic armor of future fire projectiles at hypervelocity.

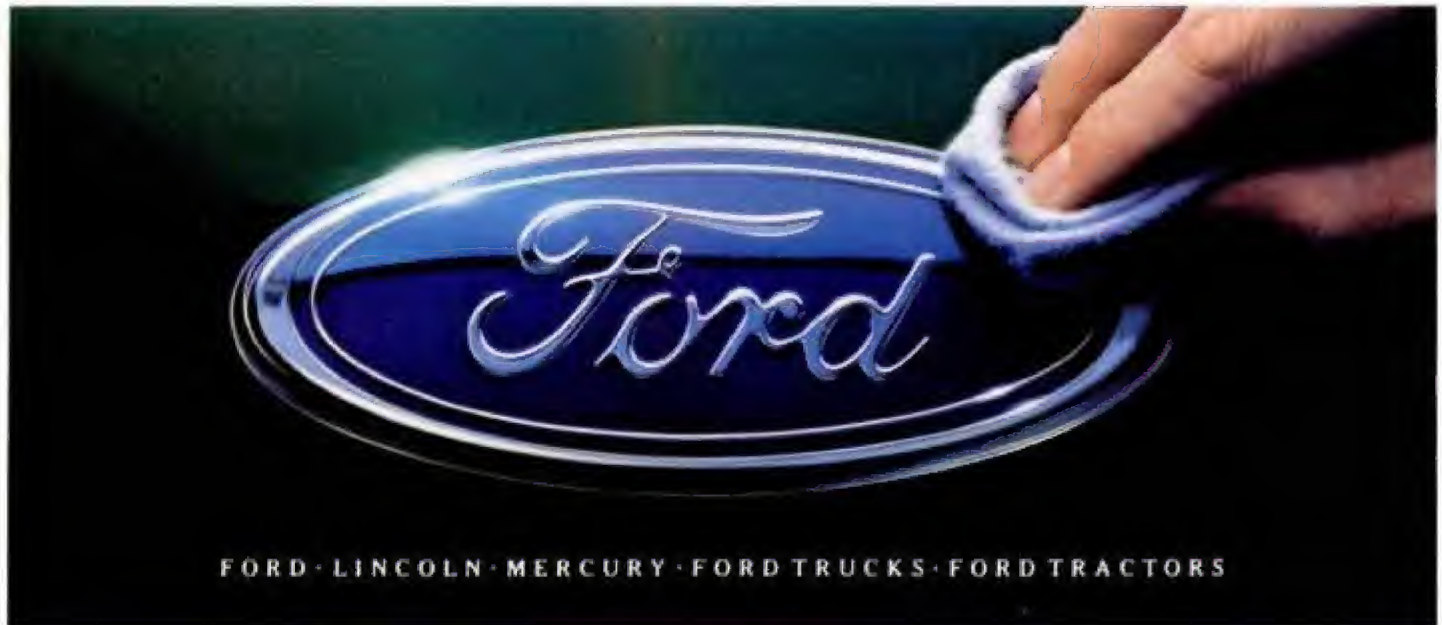
However, Kaman Aerospace Corp. is developing a "coil" gun which requires less power to achieve similar results. The Kaman coil operates on the principle of a "traveling" electromagnetic wave in

which small segments of the coil—integrated into the barrel of the gun—are electrified sequentially. This results in a reduced energy requirement as compared to the typical rail gun in which

current must be supplied to the entire length of the rails continuously.

Will it work on battlefields of the future? Proponents call it "the greatest invention since gunpowder."

Our 6 year warranty on powertrains is backed by 7 years of Quality.



Since 1981 owners of Ford Motor Company cars and trucks have reported fewer problems than owners of any other vehicles designed and built in North America.*

Not just when they're new, but thousands of miles down the road.



And all our new cars and light trucks are backed by a 6 year, 60,000 mile powertrain warranty.**

That's what happens when you make
Quality Job 1.

*Based on an average of owner-reported problems in a series of surveys of '81-'87 models designed and built in North America.

Restrictions and deductible apply. Ask your dealer for a copy of this limited warranty. **Buckle up—Together we can save lives.

Microprint: a continuous strip of microfilm containing the text of this advertisement.

PM COMPARISON TEST

MASS TRANSIT



Chevy Astro is typical of minivans, with seating for eight adults.

We test the 7 entries in the rapidly expanding family van market.

So what if it looks like the container your Corvette was shipped in? The average minivan packs two to three times the cargo volume of an equivalent-length compact sedan, comfortably seats seven or eight adults, easily tows your bass boat and sips frugally from the gas pump all the while.

There are now seven minivans on the U.S. market. The three American vans—from Ford, Chrysler and General Motors—are comparatively big, brawny and tough, with V6 engines available and

tow-ratings up to 5000 pounds. At the track, the Astro was a tenth of a second slower than the Aerostar in the quarter-mile, a tenth of a second faster than the Caravan.

The three were evenly matched in every other test, too, from slalom to fuel economy. The Caravan posted the best handling figures, mostly because of its superior Eagle GT tires. Fit those on the Aerostar and Astro, and our track test would have been a 3-way toss-up.

Bottom line is, the three American vans are a



MITSUBISHI



VOLKSWAGEN



NISSAN

toss-up. If you're looking for an 8-passenger car, you probably want a Dodge Caravan. If you're looking for a high-style all-rounder that's equally at home at the lumber yard or the country club, you want a Ford Aerostar. If heavy hauling is priority one, the Chevrolet Astro is the van of choice.

As it worked out, our three American minivans all ranked about the same, and the three Japanese clones grouped themselves together, too. The Mitsubishi, Toyota and Nissan are virtually identical. Even knowledgeable van mavens have to check the emblems to identify one from another.

The Japanese vans bury their engines in a wide box that extends from between the front seats into the rear cargo area. Aside from cutting up the interior, it's next to impossible to crawl from the driver's seat to the rear seats as you can in the American vans—this makes engine maintenance a nightmare.

Then there's the famous Volkswagen Vanagon, a direct descendant of the first Beetle-based VW van. The low-rpm growl of the rear-mounted flat-Four will bring memories flooding back, particularly if you're one of those millions of Americans who learned to drive in Mom's Beetle.

How do these boxes stack up? Well, after running them through our usual battery of tests at Raceway Park in Englishtown, New Jersey, and racking up hundreds of miles in back-to-back comparative driving over a wide variety of roads and highways, we came to the conclusion that we couldn't reach a conclusion. Which van you should buy depends on what you're going to do with it.

Chevrolet Astro CL

If you need a tough workhorse that's still genteel enough for carrying the kids, the Astro has pleasant styling and a comfortable interior, but also gobs of torque, more cargo capacity than the Ford or Chrysler, and the ability to tow a substantial trailer or boat.

This vehicle is also sold by GMC dealers as the Safari. The Astro is derived from a mini-pickup—in this case, the best-selling S-10. This means rear-drive, a full frame, and with the optional 4.3-liter V6, 5000-pounds towing capacity—the brawniest in this class.

On the road, the Astro didn't feel as surefooted to us as several of its rivals. We would have liked more road feel in the steering and less body lean in corners. We felt the shock absorbers could have been valved for more

control, also. The Astro's vertical swinging rear cargo doors aren't as convenient as the lift-up tailgates of the Ford and Chrysler. Our most serious complaint is the lack of front leg room in the Astro. Between the engine cover, wheelwells and dashboard, there's little room for feet.

Dodge Grand Caravan SE

The best family van is the front-wheel-drive Chrysler, sold as the Dodge Caravan or Plymouth Voyager. The Caravan has been substantially improved in many ways for 1988, without losing its happy, do-anything ambience. It's a particularly clever design, one that shouldn't go out of style for a long time to come.

Most significant is a new stretch version that's 15 in. longer than the short-wheelbase model. The extra cargo and passenger room is welcome, and as a bonus, the long, 119-in. wheelbase makes for much less pitching on bumpy roads. Even the long-wheelbase Caravan is still shorter than, say, a Taurus, Celebrity or similar mid-size sedan, so it's a cinch to drive and park.

Also new is a 3.0-liter V6 engine built by Mitsubishi. Its fuel-injected 140 hp gives the Caravan nearly identical performance to archrivals Aerostar and Astro.

The Caravan has simple, straightforward styling, more like a station wagon than a truck. You don't have to step over the front wheels to get in as you do with the VW and Japanese vans. Once inside, you're presented with a completely color-keyed interior, comfortable bucket seats, a full set of analog gauges and the general ambience of a Chrysler sedan. A variety of rear seat options are available, and the seats fold, remove and otherwise adjust to a variety of uses.

The Caravan was originally designed off Chrysler's ubiquitous K-car unitized body/chassis. There are no frame rails per se, and thus no place to attach heavy-duty towing equipment. A maximum towing capacity of 2750 pounds limits the Caravan to small boats, pop-up campers and other lightweight towables. If you need serious towing ability, look to Ford or GM.

Some minivans feel truck-like in everyday driving. But driving the Caravan is simplicity itself. Front-



FORD



TOYOTA



DODGE

MASS TRANSIT

wheel drive and optional Eagle GT tires combined to produce the sharpest handling in this group, comparable to Chrysler's excellent front-wheel-drive sedans.

Even if some family members are apprehensive about driving a van, the Caravan's passenger car driving position, controls and handling will make them feel right at home. For many people, what's most appealing about the Caravan is how normal it is.

Ford Aerostar XLT

Nobody would accuse the Aerostar of being normal. No minivan has a more innovative shape, with dramatic aerodynamic styling that is sure to be copied by other manufacturers in the future. In 1988, however, this is by far the most modern-looking of all vans, with a surprisingly classy feel.

The Aerostar also enjoys a long hood and full-length doors, which make it easy to get to the engine for maintenance, and easy to get in and out without a high step-over. The rear lift-gate has a low lift-over, too.

The Aerostar has the most modern, most luxurious seats and cockpit of any minivan. The thing you notice first is the huge dashboard, which fills the entire underwindshield area. The controls are somehow very European in their clever layout, and the optional digital dashboard is the least-obtrusive we've encountered.

The driving position is excellent, high and with good visibility, and the stylish basket handle bucket seats have useful armrests and adjustable lumbar support. Even the floor-mounted, 4-speed automatic shifter is easy to use, while the fatly padded steering wheel might have been pulled off a sporty Merkur XR4Ti.

The Aerostar is built around Ranger mini-pickup drivetrain components. This means a rear-drive chassis with real frame rails, allowing the Aerostar a maximum

towing capacity of 4900 pounds. Surprisingly, considering its pickup origins, the Aerostar has excellent handling. It feels stable and secure, even when fitted with the M+S-rated Firestones of our test vehicle. A set of high-performance Goodyear Eagle GTs would make it even crisper and more fun. The Aerostar was an outstanding performer at the track, and quickest of all in the quarter-mile, even though it gives away 1400 cc to the Astro.

The Aerostar is a pretty, powerful, good-handling van with personality and style, and the classiest member of this group.

Mitsubishi Wagon LS

The Mitsubishi is slightly faster, slightly better handling, and slightly more capacious than the other two Japanese minivans. Its 2.4-liter Four is marginally more powerful than the similar engine in the Nissan and Toyota.

Where the Mitsubishi really shines by comparison is on a winding country road. Handling is surprisingly stable, given the difficulties of making an empty box with most of the weight over the front wheels handle at all. The short wheelbase makes for nimble transient handling, and the Mitsubishi won our slalom test thanks in part to Yokohama 360 tires.

The Mitsubishi also has the most versatile interior of the three Japanese vans, with easily reconfigured bucket seats which can be spun around, slid back and forth or removed completely. Our silver test van had a pleasant 2-tone gray interior that was very attractive. Other nice features are big analog instruments, conveniently placed controls and comfortable seats. And Mitsubishi's construction quality was superb on our test vehicle.

Given the basic vehicle parameters, Mitsubishi's designers have done an excellent job. But there's no way this "cab-over" configuration can be as useful, comfort-

The seven vans we road tested divide into three neat categories: domestic, Japanese and the unique VW.



CHEVROLET

DODGE

FORD

SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/MODEL	BASE PRICE	PRICE AS TESTED	ENGINE	TRANSMISSION	WHEEL-BASE (in.)	LENGTH (in.)	WEIGHT (lb.)
Chevrolet Astro CL	\$11,079	\$18,514	150-hp OHV 4.3-liter V6	4-speed automatic	111.0	176.8	3500
Dodge Grand Caravan SE	12,561	16,813	140-hp SOHC 3.0-liter V6	3-speed automatic	119.1	190.5	3200
Ford Aerostar XLT	11,132	16,363	140-hp OHV 2.9-liter V6	4-speed automatic	119.0	174.9	3600
Mitsubishi Wagon LS	14,289	16,654	109-hp SOHC 2.6-liter Four	4-speed automatic	88.0	175.2	3252
Nissan Van GXE	15,099	18,039	106-hp SOHC 2.4-liter Four	4-speed automatic	92.5	178.0	3375
Toyota Van LE	14,998	18,126	101-hp SOHC 2.2-liter Four	4-speed automatic	88.0	175.8	3050
Volkswagen Vanagon GL Syncro	15,320	21,985	95-hp OHV 2.1-liter Flat 4	4-speed manual	96.9	179.9	3600

1. Best speed while weaving through seven cones placed 100 ft. apart; the higher the speed, the better the transient handling.
2. G-forces generated during steady-state cornering around a 200-ft.-dia. circle; cw = clockwise, ccw = counterclockwise.
3. The number of standard-size grocery bags that will stand upright (1-in. crush space permitted) in trunk with rear seats up.

able or safe as the larger American vans. There's also no room to put in a V6, so maximum towing capacity is only 2000 pounds.

Nissan Van GXE

Nissan's van has a 4-in.-longer wheelbase than the Mitsubishi and Toyota, is 3 in. longer and weighs 100 pounds more. It has mild performance from a low-powered engine. Correspondingly, the Nissan returned the best gas mileage in our group, at nearly 24 mpg. That's a substantial 5 mpg better than the Aerostar, for example.

The Nissan has a rather choppy ride because of the short wheelbase, but makes up for it with nippy handling, despite being shod with Toyo Z M+S-rated all-season tires—not known for being a handling tire.

The GXE has excellent brakes—by far the best stopping distance of the Japanese vans and comparable to the Eagle GT-shod Dodge.

Toyota Van LE

Like all Toyotas, the van is superbly built and finished. And it's outfitted with a plethora of electronic equipment, including a high-tech car sound system and optional refrigerator large enough to hold a 6-pack. The instruments are clear analog units. With only 101 hp from 2.2 liters, the 3000-pound Toyota is significantly slower than the Mitsubishi, not to mention the American V6s.

Where the Toyota scores big is in interior comfort. The front bucket seats are comfortable, the rear captain's chairs plush and cushy. Dual air conditioners and dual sunroofs emphasize the passenger-oriented design of the Toyota. If your assignment more often entails transporting a Cub Scout troop to the church hall than trailering an Airstream cross-country, Toyota's lavishly outfitted van could be a reasonable choice.

Volkswagen Vanagon GL Syncro

The Vanagon is in a class by itself in many ways. It has far more interior room than any of its competition. And that room is usable—fully 10 in. higher floor to ceiling. The rear-mounted Beetle engine—now 2.1 liters and watercooled—is durable, simple and out of the way, so the interior is spacious and unmarred by an engine cover under the dash or between the seats. Even the rear engine cover turns into a convenient luggage area or can be padded to become part of a fold-out bed.

Best of all, the Vanagon is the only van available with 4-wheel drive. Based on the full-time 4wd used by Audi and VW on sedans and wagons, the van system is also full-time, with a manually locking center differential. The nicest part about it is that you don't know it's there. Unless you were told, you'd never figure out this vehicle had 4-wheel drive.

The Vanagon needs more horsepower. Twenty-one point six seconds in the quarter-mile is one of the slowest runs we've ever recorded. And this vehicle is available with an automatic transmission, which would surely slow it down even more. In sharp corners, the VW doesn't feel all that stable. But 4-wheel drive keeps it glued to the road for surprisingly good test figures.

Compared to more modern designs, the VW offers a rather poor driving position and very high step-in over the front wheels. The ergonomics seem old-fashioned, too. And engine noise is high.

Vanagon enthusiasts don't care. Like many unconventional machines, the Vanagon has a faithful following. They love the old box for its spaciousness, 4-wheel drive and durability.

No doubt, Volkswagen can continue to sell the Vanagon just the way it is for as long as they want. Because in truth, it doesn't have to compete with other vans, only with itself. And surely, the Syncro is the best VW van ever—the quintessential box on wheels. **PM**



TEST RESULTS

GAS MILEAGE (EPA city/ PM test)	1/4-MILE (sec. @ mph)	0-60 mph (sec.)	BRAKING (ft.) (60-0 mph)	SLALOM ¹ (mph)	SKIDPAD ² (cw/cw)	CARGO VOLUME ³ (cu. ft.)	INTERIOR SPACE INDEX ⁴	TEST TRACK RANKING ⁵	ROAD TEST RANKING ⁶	OVERALL RATING ⁷
17/19.12	18.844 @ 71.42	13.91	134	54.26	.63/.63	277	204.00	3	3	3
17/19.25	18.948 @ 73.46	14.37	127	54.70	.66/.69	272	173.92	1	1	1
16/18.48	18.748 @ 73.77	13.73	132	52.13	.62/.64	257	178.95	4	2	2
18/21.80	19.811 @ 67.51	13.89	138	56.11	.64/.67	261	187.37	2	4	4
18/23.40	20.786 @ 64.14	15.03	128	53.65	.61/.63	255	182.66	5	6	5
21/21.26	19.655 @ 63.51	15.90	145	55.27	.60/.62	240	167.95	7	5	6
16/19.20	21.575 @ 61.85	20.95	139	52.25	.68/.67	466	199.89	6	7	7

4. Front-seat width × headroom × legroom + rear-seat width × headroom × legroom ÷ 1000.

5. Points are awarded from best (1) to worst (6) in each category. Fewest total points ranks first, and so on.

6. Subjective ranking on the road by a team of testers; cars are graded by "feel," independent of test track results.

7. Average of Test Track and Road Test ratings. Road Test score breaks ties. Bold numbers show best performance.



SAAB 9000

5 MILLION SMILES

What groups these three cars together is that they're unpretentious—and good.

MICHAEL LAMM, Contributing Editor



Intercooled, 16-valve, 160-hp turbo engine (above left) in Saab 9000 drew praise from majority of owners. Almost three-quarters of owners opted for leather interior (above right).

One's a Swede, one's an American and one's a NUMMI. The latter's a new breed, a Toyota/Chevrolet from New United Motor Manufacturing, Inc. We surveyed owners of the Saab 9000, the NUMMI Nova and Pontiac's Bonneville and found that they love driving these cars.

Chevy Nova

East meets West. The point of convergence: Chevrolet's new Nova—basically, a Toyota Corolla assembled by American workers. These workers, 90 percent of whom had worked for GM before, were trained by the Japanese and operate in what's now a "Japanese" plant environment.

The Nova represents a 50/50 joint venture between Toyota and Chevrolet. In February 1983, the two automotive giants set up an independent subsidiary in California.

Called NUMMI (New United Motor Manufacturing, Inc.), the facility assembles Novas and sells them to Chevrolet. Engines and transaxles are wholly Corolla, shipped over from Japan, but the body, interior, tires and other parts are mostly U.S.-made.

The point is, if you're worried that we Americans can't build cars as well as the Japanese, don't. We can, and we're doing it. Owners *really* like the way the Nova's put together. And the NUMMI car has had very few bring-backs.

You're probably aware that, in terms of fit, finish and overall finesse, Japa-

5 MILLION SMILES

nese Toyotas pretty much rule the road. They come out on top every time we do a comparative *Owners Report* roundup. Nobody—not even the Germans—produces cars that are more troublefree and reliable than Toyotas. And we're talking now about *all* Toyotas, regardless of price or model.

So when time came to survey Nova owners, we wondered how this car would stack up against its Japanese counterparts. Again, no need to worry. Sixty-one percent of our Nova respondents rated workmanship *excellent*. Another 38.2 percent gave workmanship the next-best score of *good*. Cumulatively, that's better than the Japanese-built Toyota Corolla we surveyed in September 1985. (The Corolla did get, though, a higher percentage of pure *excellent* votes—70.9 versus 61.0.

When it came to specific comments about quality and workmanship, a Michigan dentist beamed, "My happiest discovery is that a new car doesn't have to come with the usual flaws. My previous cars have all needed corrections and adjustments. This Nova appears to be perfect in every way."

A Wisconsin retiree echoed, "I bought my Nova because it has a Corolla engine, Toyota electrical system and yet was made in America by American workers with Japanese motivation. Maybe the plan of Americans and Japanese working together can correct Detroit's past sins and sloppiness!"

"We're impressed," asserted a Wisconsin secretary, "with the paint job and the overall fit of doors and trim. This has to be the Japanese influence on attention to detail."

And a Michigan manager observed, "Toyota's quality standard might teach Chevrolet a thing or two!"

In fairness, we have to point out that the Nova's quality is as much a reflection of NUMMI's management as of its workers. If the plant weren't run in a very Japanese management style, the workers undoubtedly wouldn't put these cars together the way they do.

When we asked Nova owners if they'd had any mechanical problems, 83.1 percent said no. That's an excellent re-

sponse and approximately the same as the 84.4 percent who'd had no mechanical problems with the Corolla.

And yet, while it comes closer than most cars, the Nova still isn't quite perfect. We did hear a few gripes and suggestions for improvements.

Lack of horsepower, especially with the automatic transaxle, headed the complaint list. Nearly 9 percent of our owners agreed with this Illinois engineer, who observed: "Needs more pep—doesn't have the guts of my husband's Tercel!" A Texas manager added, "You can really feel the air conditioner cut in—it pulls down the motor."

"Front seats are too hard—not enough padding," groaned an Alabama bookkeeper. An Ohio operator added, "The shoulder harness cuts into my neck and can't be adjusted. It's uncomfortable and restricts movement." "Weak defroster—doesn't do the job" pointed out a Texas salesman, but an Arkansas welder pointed out that, "The defroster was tricky to figure out. You have to put it on *fresh air* or everything fogs up." And an Ohio technician told us, "There's no light in the dash to illuminate the controls for heat, vent, fan and so on."

A few respondents complained that it also took a while before dealers were stocking even the most common service parts. "The oil filter for my Nova wasn't

available at the dealership when I went in for my first checkup," said an Arkansas factory worker. And a Michigan service provider: "I had an accident that necessitated ordering some body parts for my Nova. They came in one at a time from Japan, and the last one took 3 months to get here."

But praises drowned out these relatively minor complaints by a wide margin. A Wisconsin farmer: "Rides like a much bigger car—very solid feeling on the road. It handles great and gets terrific mileage." A Colorado teacher: "Handles extremely well, especially the fwd in snow and on ice. The real test, though, came when we took a 1000-mile vacation in our Nova. We were all comfortable, and the trunk was large enough to handle the luggage for our family of four."

A Tennessee real estate agent: "On a trip to Florida with four adults aboard and the air conditioner going most of the time, we averaged 40.5 mpg. I am very pleased with this car's economy. Power to pass is another pleasant surprise." A Colorado banker told us, "The Nova's economy surprised me. We've gotten as high as 45.6 mpg on the highway and average around 40.0 mpg."

"There isn't a spot they didn't paint inside and out," smiled an Illinois data controller. "The factory puts on special protection against nicks plus galvanized steel to guard against rust. All fluid levels are visible under the hood—everything's easy to check."

The general consensus was summed up in a brief postscript by this Texas clerk. "It's a great little car," she wrote. "There's room for five, and yet it's small on the outside. It runs great and doesn't use much gas and has good pickup when you need it. Hope they keep making Novas this well, because I intend to buy another one!"

Saab 9000

When we asked him what he *really* liked about his new Saab, a Wyoming rancher confessed, "Out here in the wide-open spaces, the 9000 Turbo can be driven up to 135 mph for miles at a time. It's perfectly quiet at that speed and remains very stable."



CHEVROLET NOVA



PONTIAC BONNEVILLE

5 MILLION SMILES

In our survey of Saab 9000 owners, performance, handling, workmanship, styling and comfort all came across as the car's strongest points. Owners who voiced complaints—and there were some—admitted they were mostly picking nits. We'll get to those in a moment.

Much louder, though, were the voices of praise. An Ohio engineer, who'd toured Europe in his 9000 on a fly/buy plan, told us, "On the *Autobahn*, I'd set the cruise control on 90, sit back and relax. The Saab takes no sass from BMW or Mercedes, especially in 60- to 100-mph sprints."

Despite scattered grumbles about turbo lag below 3000 rpm, Saab's docile, 16-valve, 2.0-liter, intercooled, 160-hp Four amazed nearly everyone with its flash and power. A New York executive burred: "The Saab 9000 just *sails* along. The turbocharged engine purrs so effortlessly that 75 mph feels like 50. I'm not basically a fast driver, but the car has so much power that before I know it, I'm flying low. I really love to

drive this car."

Handling also came in for enthusiastic approval. A New York dentist beamed, "The new Saab is the best road car I've ever driven. Its handling is utterly fantastic. It puts most sports cars to shame, yet it's also a fabulously comfortable family car."

The EPA classifies the 9000 as a "large car," an honor this top-of-the-line Saab shares with the likes of big Cadillacs and Lincolns. With its 60/40-split rear seatbacks folded flat, the Saab 9000 hatch contains nearly as much space as a full-sized station wagon: 56.5 cu. ft.

On the topic of riding comfort, most respondents agreed with the Colorado real estate agent who said, "Seat adjustments are great for a tall person like me. The Saab's European ride feels firm but comfortable. I also find all controls convenient and easy to use."

Several disagreements on that last point. Some owners chastised Saab for not offering tilt steering (the column does telescope) and for making the radio buttons too small. The automatic climate control also came in for some criti-

cism because it reverted to zero each time the ignition was turned off. This meant the driver had to reset the system when he started the engine.

But the vast majority of owners told us plainly and clearly that they considered the 9000 the best Saab ever, and an amazing number spoke from past experience. In our survey, 16.4 percent had owned Saabs before—a figure that underscores the Swedish automaker's continuing ability to please.

When it arrived in the U.S. in late 1985, the Saab 9000 Turbo cost roughly \$23,000. That price has gone up since then, one reason being the weakness of the dollar abroad. With the heavy complement of standard equipment on the 9000 turbo, you can round off and consider this a \$30,000 car. The most recent 9000 model is the "S" which is minus the intercooled turbocharger. In our survey, due to the newness of the 9000S, only 2.2 percent of our respondents reported owning it.

Drivers of earlier 9000 Turbos grouched mildly about having to let the

(Please turn to page 142)

CHEVY NOVA OWNERS REPORTS*

Total miles driven	1,490,374	Styling	37.7	Average	0.8	Dealer service opinion:	
Average miles per gallon:		Ride	30.9	Poor	0.0	Excellent	29.4%
With 5-speed manual transaxle:		Comfort	27.5			Good	45.6
In town	31.3			Comfort opinion:		Average	21.3
On the highway	39.8	Specific dislikes:		Front seats:		Poor	3.7
With 3-speed automatic:		No complaints	18.3%	Excellent	62.2%	Number of vehicles owned:	
In town	28.8	Not enough power	8.9	Good	33.5	This car only	45.8%
On the highway	34.9	Uncomfortable (hard) seats	7.9	Average	3.6	Two cars	39.0
Transaxle choices:		Weak defroster	7.9	Poor	0.8	Three cars	7.2
3-speed automatic	59.8%	Price too high	5.4	Rear seats:		Four or more cars	8.0
5-speed manual	40.2	Poor radio sound quality	5.4	Excellent	39.7%	Makes of other cars owned:	
Series choices:		What changes would you like?		Good	48.5	Chevrolet	41.1%
Nova (standard)	65.0%	No changes	34.5%	Average	10.9	Ford	19.9
Nova CL	35.0	Better defroster	5.3	Poor	0.8	Oldsmobile	13.2
Why did you choose the Nova?		More horsepower	4.9	Had any mechanical trouble?		Pontiac	11.0
Styling	38.4%	Larger console	4.4	No	83.1%	Toyota	9.6
Good value/price	30.6	Brighter instrument lighting	4.4	Yes	16.9	Would you buy a Nova again?	
Economy of operation	30.2	More comfortable shoulder harness	3.9			Yes	63.9%
Built in U.S.A.	16.4	How much did you pay?		What type of trouble?		Maybe	30.9
Toyota engine & reliability	15.9	Average	\$8919	Transmission	13.2%	No	5.2
Riding qualities	10.8	Range	\$8896-\$11,000	Heater/shifting	10.5	Would you buy Chevrolet again?	
Specific likes:		Workmanship opinion:		a/c and electrical system	7.9	Yes	60.8%
Fuel mileage/economy	63.6%	Excellent	61.0%	Dealer repairs satisfactory?		Maybe	32.1
Handling	43.2	Good	38.2	Yes	59.4%	No	7.2
				No	40.6	Age distribution of owners:	
						Under 29 years	35.3%
						30-49	41.8
						50-plus	22.8

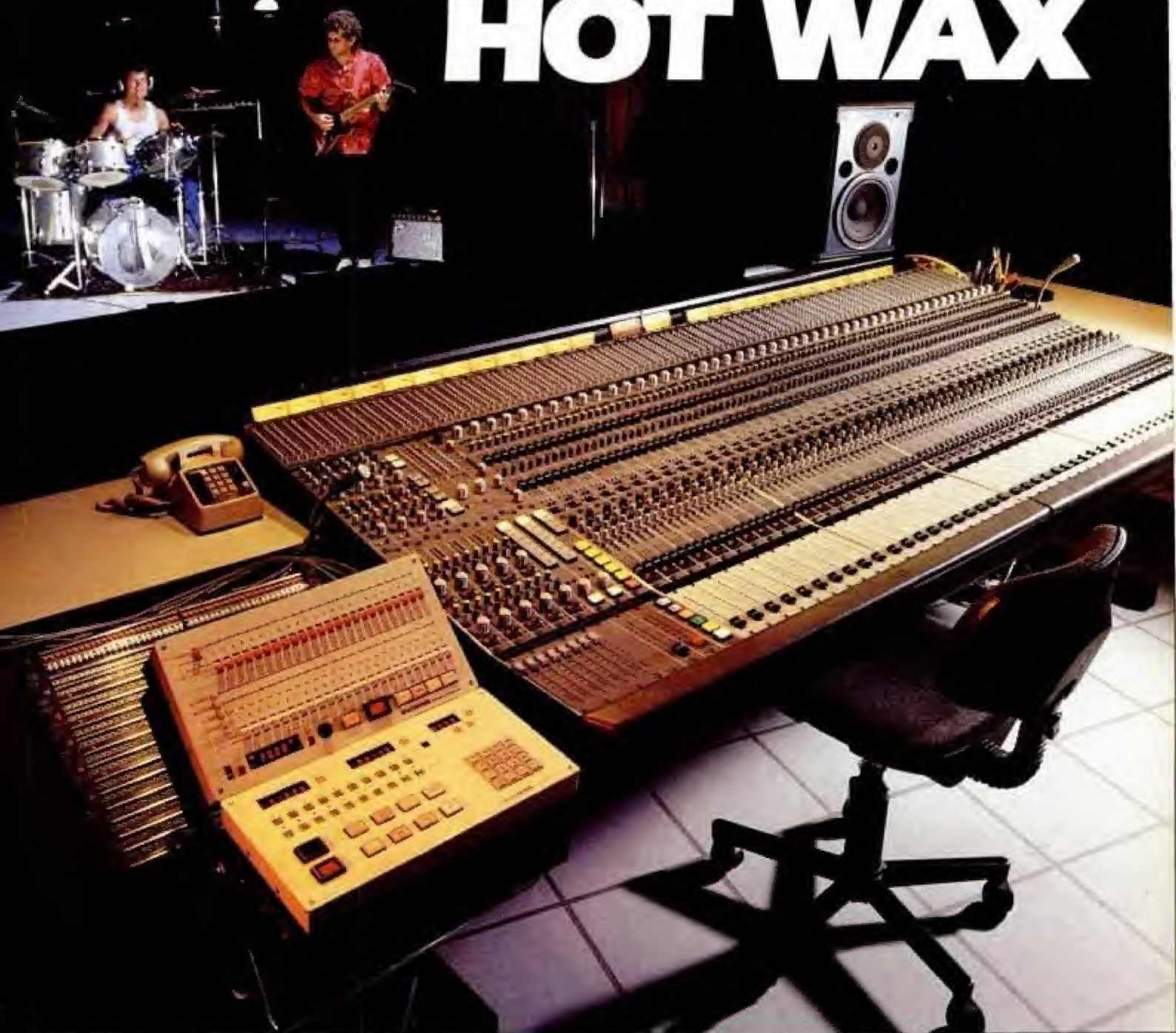
*Percentages might not equal 100% due to rounding or an insufficient amount of data.

SAAB 9000 OWNERS REPORTS*

Total miles driven	2,561,186	Styling	40.8	Front seats:		Good	44.2
Average miles per gallon:		Power	33.8	Excellent	88.3%	Average	14.0
With 5-speed manual transaxle:		Specific dislikes:		Good	10.4	Poor	5.1
In town	22.0	No complaints	19.6%	Average	0.9	Number of vehicles owned:	
On the highway	28.2	Must reset climate control	7.2	Poor	0.3	This car only	14.9%
With 4-speed automatic:		Noises and rattles	6.4	Rear seats:		Two cars	47.3
In town	20.3	Rear hatch heavy to lift	6.4	Excellent	74.4%	Three cars	22.3
On the highway	25.8	Balky shifter	6.0	Good	23.9	Four or more cars	15.5
Series choices:		No antilock braking system	6.0	Average	1.0	Makes of other cars owned:	
Saab 9000 Turbo	97.8%	What changes would you like?		Poor	0.6	Saab	12.7%
Saab 9000S	2.2	No changes	14.1%	Had any mechanical trouble?		Chevrolet	12.3
Option choices:		ABSless brake squeal	13.4	No	51.1%	Volkswagen	11.9
Leather interior	71.9%	Climate control memory	8.5	Yes	48.9	Honda	11.6
Electric sunroof	15.7	Make power seats standard	6.0	What type of trouble?		Ford	9.7
Why did you choose the Saab 9000?		Stronger struts for liftback	5.3	Electrical system	28.7%	Nissan/Datsun	7.8
Styling	40.1%	How much did you pay?		Graphic display	12.0	Would you buy a Saab 9000 again?	
Performance	34.2	Average	\$23,474	Air conditioning	10.7	Yes	71.6%
Roominess	25.0	Range	\$17,900-\$29,000	Transaxle	8.7	Maybe	24.3
Handling	18.1	Workmanship opinion:		Oil leaks	8.0	No	4.2
Owned Saabs before	16.4	Excellent	71.3%	Sunroof mechanism	7.3	Would you buy a Saab again?	
Specific likes:		Good	27.4	Dealer repairs satisfactory?		Maybe	47.3%
Comfort	54.2%	Average	1.3	Yes	66.4%	No	35.5
Handling	43.8	Poor	0.0	No	33.6	Yes	17.2
Performance	42.8	Comfort opinion:		Dealer service opinion:		Age distribution of owners:	
				Excellent	36.8%	Under 29 years	6.8%
						30-49	67.4
						50-plus	25.6

COVER STORY

AMERICAN HOT WAX



Music recording has advanced light years in the two decades since The Beatles produced *Sgt. Pepper*. Today's artists use digital tape, multitrack mixing, and even remote recording via satellite and fiberoptic transmission.

BY STEVE DUPLER

This customized mixing board is the nerve center of Cherokee Studios' control room.

ress at Master Sound Astoria in New York City. And though musical stars routinely rocket into orbit from modern studios such as this one, something special is being launched today.

The producer and the chief engineer

sit attentively at MSA's mixing board, which itself appears capable of providing navigational guidance for a moonshot. Seated beside these intense individuals is a genial-looking fellow who sets his wide-brimmed hat on the back of his head before positioning his fingers on the guitar across his chest.

He's Nile Rodgers, the musician and producer responsible for hit albums by

AMERICAN HOT WAX

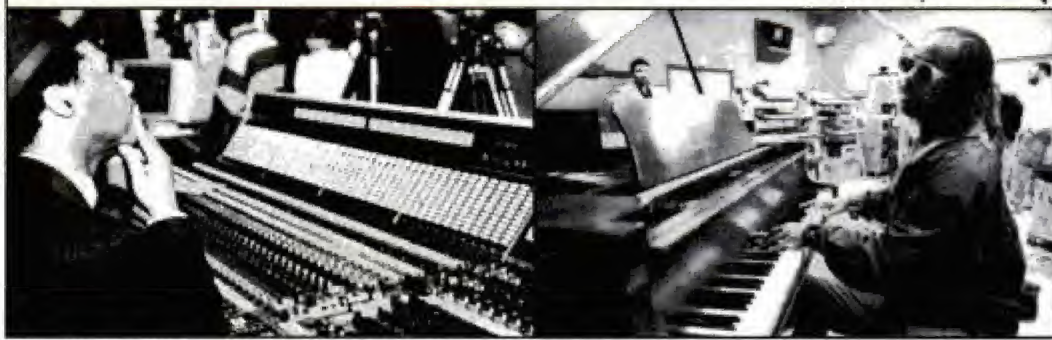
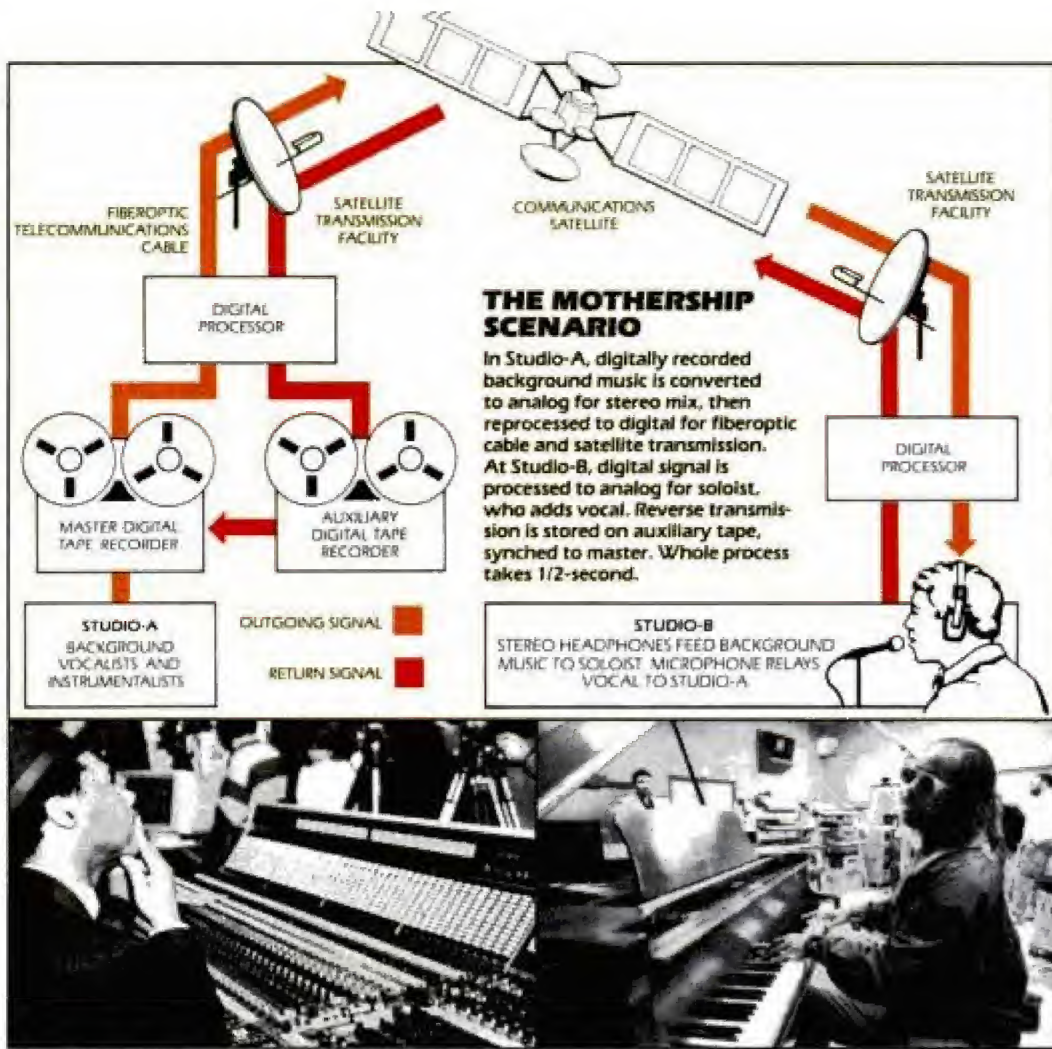
artists such as Madonna, David Bowie and Duran Duran. Rodgers and his companions peer intently at a video monitor upon which Stevie Wonder and producer Quincy Jones appear. They are in another, similarly equipped studio in Los Angeles. This group of musicians and technicians, separated by some 3000 miles, is about to link the two studios in the first simultaneous, remote digital recording session in history.

Utilizing digital satellite communications equipment operated by Teleport Communications in Staten Island, New York, the musical link was established across 45,000 miles of space, as shown in the accompanying illustration. Without leaving his chair at MSA in New York, Rodgers was able to record the guitar accompaniment to Wonder's antidrugs song "Stop, Don't Pass Go" at the very same moment the vocalist sang the lyrics.

In another remote digital link-up that same March day, Wonder's harmonica work traveled from Los Angeles to New York where it was overdubbed onto the soundtrack of TV's "Moonlighting" theme.

Although this was the first simultaneous "long-distance" digital recording session, quite a few others have utilized the capabilities of digital audio—storing the musical signal in a numerical computer format, and then beaming it to another location via satellite or land-based telecommunications lines. Recording industry professionals refer to the process as "The Mothership Scenario."

"What we are going to see—and not too far in the future—is a situation where musicians and producers will work in small, self-contained home studio units that are equipped with the highest-tech audio and communications gear," says Gary Helmers, executive director of the Los Angeles-based Society of Professional Audio Recording Studios.



Nile Rodgers (left) in New York and Stevie Wonder in Los Angeles cut the first live, remote recording.

BRUCE WILLIS GOES MOONLIGHTING

When is actor Bruce Willis not detective David Addison? When he's "moonlighting" in the recording studio as Bruno, the harmonica-packing disciple of rhythm-and-blues.

The nature of music recording isn't the only thing that's undergoing change: So too is the nature of the performers who come to record.

In the past, music was the springboard to Hollywood for singers such as Crosby, Sinatra, Elvis and The Beatles. Increasingly, however, established stars of screen, stage and TV are migrating to the microphone. A recent case in point is the vinyl debut of Don Johnson, whose background includes numerous movies as well as TV's "Miami Vice." Even more recently, 32-year-old Bruce Willis added to his credits from film, stage and TV's "Moonlighting" when he cut *The Return Of Bruno* (Warner Records #6222ML), his first commercial recording, then took the show on the road this summer for a series of nightclub gigs.

"Bruno" is a nickname Willis acquired during his high-school years in New Jersey, when he first curled his lips around a harmonica. The album has passed the half-million mark on the *Billboard* sales charts and, despite all the electronic wizardry available to today's recording artists and engineers, the Willis you'll hear on the album is the real, unadulterated, unsweetened thing—with no artificial enhancement of the vocals or mouth-organ work. That's what John Vigran says, and as recording engineer on the project, he ought to know.

"I recorded his vocal flat, on a Neumann U47-FET microphone, without signal processors or outboard gear," says Vigran, explaining that the new, top-quality, German-made mike uses field-effect transistors in-

stead of the tubes found in vintage Neumanns. "The idea was to make it all as live-sounding as possible."

To capture even more of the ambience of a live act, says Vigran, the instrumental tracks were performed by The Heaters—"a very good, local rock-and-roll band. We cut all their tracks live, with very few overdubs. The flavor of this record was supposed to be getting away from drum machines and synthesizers."

Eventually, though, the studio's digital-computer sideman got into the act. "The mixing engineer ended up replacing some of the live drum tracks with computer drums by Wendel," reports Vigran. "Wendel," he explains, "is a sophisticated digital-computer drum synthesizer designed by Roger Nichols, who engineered Steely Dan albums in the 1970s."

Although the voice of Bruno needed no such help from musical machines, Vigran explains that live-sounding doesn't necessarily mean the vocals on the album were recorded in a single pass.

Vigran tells PM that for *The Return Of Bruno* he employed the standard engineering tactic of recording a composite track from the lead vocals sung by Willis. In this routine, the singer records several takes of a vocal. The engineer later edits these takes and splices the best segments to assemble the finished track.

"You have to remember," Vigran explains, "that Bruce was working on the film 'Blind Date' in the daytime, and then we would get him in the studio at night, so he was pretty tired. But the setting seemed to energize him."

The studio settings for *The Return Of Bruno* would probably excite and energize the most jaundiced veteran of the performing arts. The album was cut on 24-



Martin and Fab Four lacked the TV monitors, outboard gear, multitrack tape used by boardman Rich Joseph at Unique Recording, N.Y.



Cherokee's 56-input custom board mixed instrumentals and Bruce Willis vocals for his 24-track tape.

track analog tape recorders at several high-tech locations in the Los Angeles area, including Cherokee Studios and Bill Schnee Studios. The mixing consoles there are enough in themselves to merit comment and amazement. The one at Cherokee was customized by Toby Foster, the studio's chief engineer. The console at Schnee's—"the most incredible board I've ever worked on," testifies Vigran—was completely designed and custom-built by Foster. Either would be right at home on the bridge of the starship *Enterprise*.

Cherokee owner Dee Robb tells PM that when he and his crew first heard the Trident A-range mixing console back in 1976, they loved the sound of the board but felt some modifications could improve it.

Since that time, Toby Foster has spent a good many hours gutting and rewiring the Trident to his own speci-

fications. Cosmetically, the extremely low profile of the customized console is unorthodox. The bank of meters, called the meter-bridge, is now housed in a recessed glass well at the top of the board for optimal visibility and to prevent interference with functional hands-on controls. Even the monitor section has been relocated from the console to a remote, wheeled sidecar that can be rolled up to the 56-input board.

If working with these superprofessional boards was incredible, what, we asked Vigran, was it like to work with the moonlighting Willis in his first recording stint?

"We all had a lot of fun," says the man at the mixer. "At first, Bruce was inhibited, but by the end there was a marked improvement in his vocal performance. I almost wish we could have started the album over when we got near the end."—S.D.

"The work they complete in these small, self-contained digital studios will then be beamed to larger, world-class recording centers, where parts of a whole come in from all over the country, or even the world, and are assembled by digital editing." These large, state-of-the-art recording facilities such as MSA are the "motherships" of the scenario.

Coincidentally, Wonder's pioneering remote-digital session comes 20 years after The Beatles recorded *Sgt. Pepper's Lonely Hearts Club Band*. It is considered by many to be the finest rock album ever, and certainly one of the most influential in terms of recording technology. Looking back in retrospect, it's incredible that producer George Martin was able to achieve so much with such Stone Age tools.

If Sgt. Pepper led his band into a recording studio today, he and the boys would definitely be in for some heavy shellshock.

(Please turn to page 156)



Intricate
and graceful,
modern tower cranes
are dominating the big city
horizon and helping to build America.

POWER LIFTERS

BY DAVID MEYER; PM Photos by Todd James

As metropolitan areas continue to spread upward rather than outward, developments in tower crane technology continue to shape our big city skylines. Indeed, tower cranes are fast replacing older, smaller mobile cranes and derricks and are evolving to lift heavier loads faster.

Nowhere is the trend toward these giant lifters more evident than in the New York City borough of Manhattan, where more skyscrapers are under construction than in any other city. Jacob Grill, assistant commissioner of the New York City Department of Buildings, crane and derrick division, definitely sees a movement away from mobile cranes and guy derricks in high-rise construction.

"In the past six or seven years, street cranes have been replaced by tower, or climber, cranes that go up with the building," says Grill.

Part of the reason for this shift, he says, is in response to a traffic problem. Mobile cranes, designed for the road as well as the job site, block at least one lane of traffic as they operate from the street. To reduce congestion, mobile cranes are allowed no more than 110 days on any site south of 69th Street.

Mobile cranes, whether they use lattice "radio tower" or telescopic booms, are also limited in reach. The largest of these cranes can lift loads to a maximum

of about 400 ft. or about 40 stories. Mobile cranes only provide an advantage over tower cranes in the construction of shorter buildings or when making minor additions to completed buildings, says Grill. Mobile cranes are also used in the initial erection and final disassembly of climber crane towers.

Tower cranes are also replacing guy derricks, which use a set of guy wires and pulleys attached to a mast. They're operated remotely to hoist loads from the ground to a fixed point at the top of a structure. With this type of hoist mechanism, materials must be rehandled to be moved to the appropriate location at the top of the building. In addition, the guy derrick's complicated system of rigging must be reassembled each time another level is added to the building. Construction with the guy derrick is therefore a slower, more expensive process.

Climber cranes can be mounted externally, braced to a building laterally to prevent their 8 x 8-ft. towers from buckling, or internally within an elevator shaft or other appropriate hollow core. As floors of a building are completed, the climber cranes are raised hydraulically with a built-in jacking frame to maintain an appropriate height above the work site.

External climbing cranes, when braced to the building with the proper tie-in assembly, are unlimited in the height they can attain. An external

Framed by a Manhattan sunrise, American Pecco luffing boom crane begins a busy day.

crane is usually anchored to a 4 x 10-ft. steel-reinforced cement foundation that is sometimes supported by pylons. An external crane can also be mounted on rails so that the crane can move along a track to work in different areas of a job site.

External cranes are top climbers, with a climbing frame and hydraulic ram situated in an upper section of the crane tower below the machinery deck. To extend the tower, a new section is hoisted to the appropriate height and attached to a monorail. Bolts are removed at the junction of the tower sections. A special climbing frame—actually a tower section within a tower section—is lifted by the hydraulic ram and the new section is pulled into place by the monorail. It's bolted into place and a new section is prepared for installation. For disassembly, the external crane reverses the process and jumps itself down.

Internal cranes are usually bottom climbers, drawing themselves up within the structure of the building under construction. Instead of adding sections, these cranes have hydraulic cylinders that raise the base section of the crane through an opening—often an elevator shaft—in the floor above.

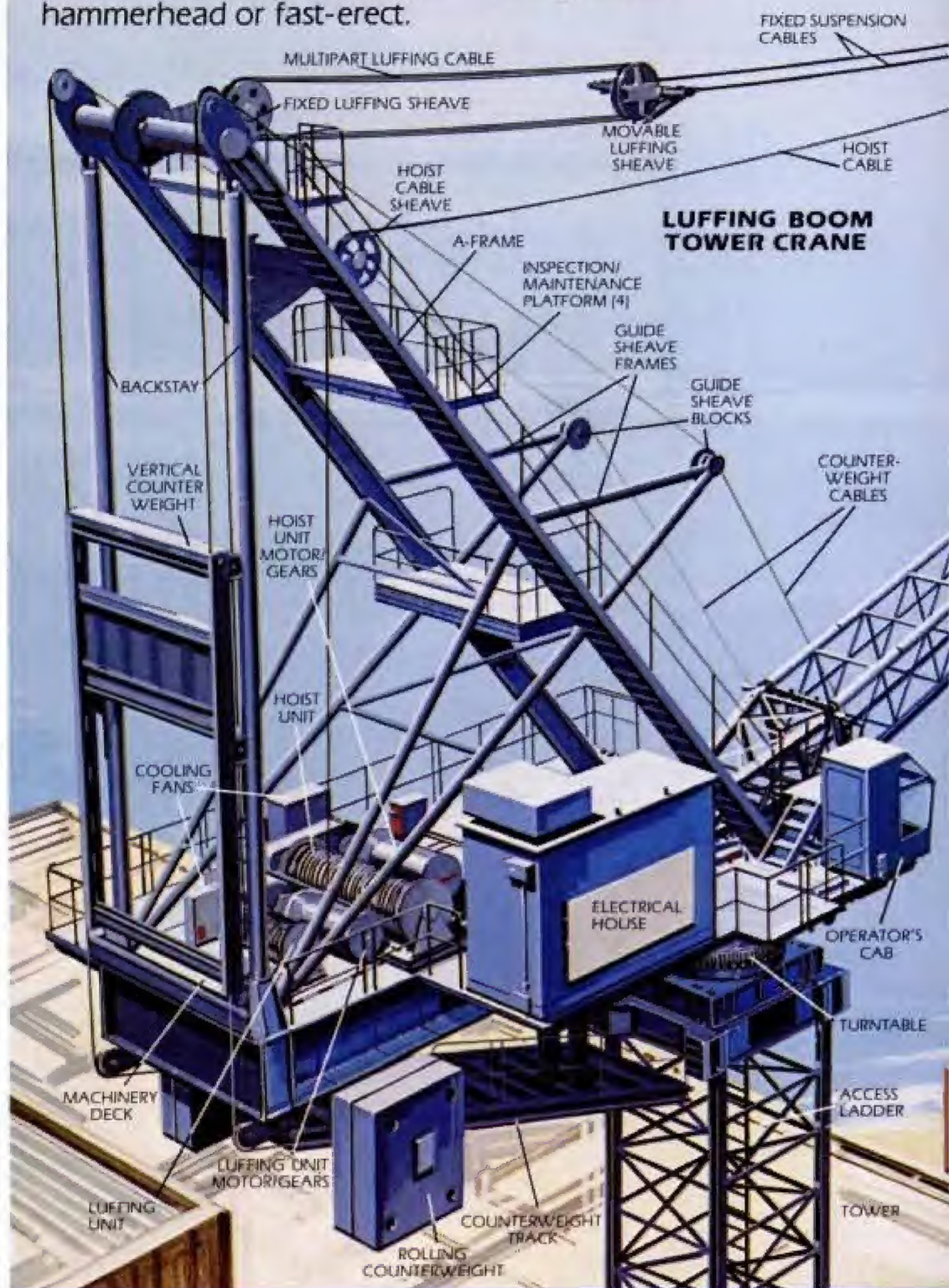
The crane base ascends a floor at a time and may extend up to 20 floors below the work site. Disassembly of an internal crane is accomplished using stiff-leg derricks, which lower the crane to the street in pieces.

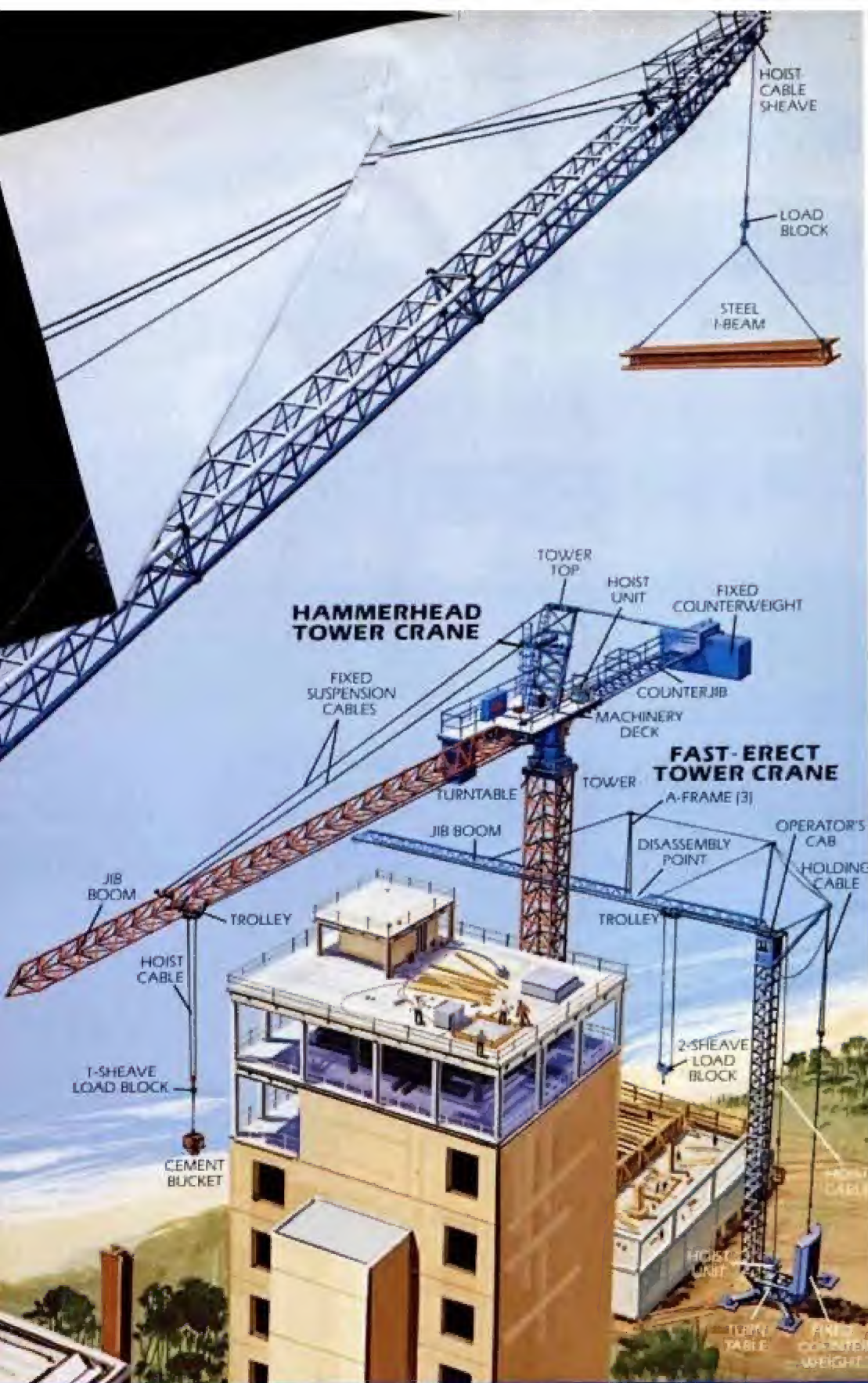
Tower cranes are characterized by their boom configurations. The hammerhead cranes have fixed booms, also called jibs, that remain perpendicular to the tower. Luffing boom cranes have jibs that pivot, conveying loads to the exact spot at the top of the building where the materials are needed.

Beyond these basic design differences, hammerhead and luffing boom cranes are marked by not-so-subtle design variations. An American innovation that was recently adopted by European crane manufacturers, the luffing boom is angled to

BIG TOOLS FOR BIG JOBS

Different building sites may require one of three different tower crane designs—luffing boom, hammerhead or fast-erect.





Photos L-R: Worker stands high above New York City on tip of American Pecco luffing boom crane; crews visit the end of the boom to grease the hoist cable sheave. Operator's-eye view of building site. Start key, condition lamp and master-stop button over gear selector. Joy stick controls left/right "slewing" action and boom angle.

work at a smaller radius using the whole boom structure for high-capacity, close-in work. A luffing boom has its hook fixed to the end of the jib and can convey loads to the desired location by increasing or decreasing its angle from the tower from a minimum of 15° to a maximum of 84° . The boom's counterweight is tucked under the coil machinery behind the cab atop the tower.

The largest luffing cranes available today use a 4-part line of wire rope to hoist more than 70,000 pounds to a 66-ft. radius from the tower at 75 fpm. Using a 2-part line, these cranes can lift lighter loads to a 197-ft. radius at a speed of 545 fpm.

On a hammerhead, the hook block is attached to a trolley that can move in and out along the boom to position loads. The counterweight and machinery sit at the end of a counterjib aligned with the boom on the opposite side of the tower. The largest urban construction hammerhead cranes now available use 148-hp engines to lift 44,000-pound loads 76 ft. per minute to a 93-ft. radius. Loads of 4000 pounds can be hoisted by the same crane to a radius of 265 ft. at speeds exceeding 600 fpm.

"Unlike mobile cranes," says New York-based consulting engineer Howard Shapiro, "each tower crane installation has its own configuration problems, with limitations on load and height based on wind speed and soil conditions."

Shapiro says that manufacturers' rating charts are often designed to show maximum load weights in optimal conditions, not real working conditions. Today's load-indicating devices, which cut out power when operators attempt to lift excessive weights or move loads to excessive radii, aren't programmed to make adjustments for wind speed. Shapiro foresees micro-processor-based indicating systems that are capable of adjusting load safety equations to job-site conditions as the next major advance in crane technology.

"Safety is of paramount
(Please turn to page 150)

SLIPSTREAM PM COMPARISON TEST SKI BOAT

Six top tournament boats clash in a battle of speed, handling, and flying roostertails.

BY FRANK SARGEANT; PM Photos by Skip Gandy

Tournament ski boats are equally at home roaring through the slalom course or posing prettily in a lagoon at Cypress Gardens. Top-performing boats shown here are the Correct Craft Ski Nautique 2001, MasterCraft Pro Star 190, and Supra Sports Comp TS6M.



SHOOTOUT



You've seen these thundering tow machines in professional water ski shows and tournaments. They're inboard-powered tournament ski boats with super acceleration and phenomenal pulling ability.

But in a comparison test of six top models at Florida's Cypress Gardens—heart of U.S. water skiing—the PM test team found that these machines have much more going for them than just being the boat of choice among hard-core skiers. They are one of the best-handling boats afloat and offer style and comfort to make conventional runabouts look dull.

The most remarkable aspect about tournament rigs is their cornering. Three bronze fins attached vertically to the keel along the center of gravity allow these boats to toe the line in turns that would send other hulls skittering dangerously sideways. The fins prevent powerful slalom skiers from pulling the boats off course during competition, and enhance handling in all situations.

Our test team quickly learned the Cypress Gardens show technique of spinning the boats 180° and

stopping on a dime from speeds of more than 40 mph. Manufacturers don't recommend this maneuver—nor do we—but it showed that these boats are nearly impossible to flip.

The test boats were armed with V8 marine conversions by Indmar or PleasureCraft Marine, generating around 240 horses from 351 Ford or 350 Chevrolet blocks. These powerplants are rated equally by the American Water Ski Assn. (AWSA).

The hulls are relatively flat bottomed, compared to most other boats, in order to produce a flat wake and minimal spray. All had a pair of seats facing aft and most had three more plush seats across the stern.

Inboards are preferred by skiers because they bury the prop deep under the hull out of harm's way. Also, the resulting forward engine mount balances the boat to keep the bow down for visibility when accelerating and allowing it to plane almost immediately, which is important for getting skiers up in a hurry.

Accessories that distinguish tournament skiers from other boats are dual speedometers, which are necessary to assure a steady reading during slalom

SKI SUPREME

AMERICAN SKIER ADVANCE

TRU TRAC II

events, and a forward towing pylon, mounted just ahead of the engine box.

The test boats, all approved for tournament competition by the AWSA, came from American Skier, Correct Craft, MasterCraft, Ski Centurion, Supra and Supreme.

We selected a winning boat based on a series of tests, measurements and observations, and though we measured speed in several ways, our ultimate criteria was handling, acceleration and

wake characteristics, which are vital in a ski boat.

In truth, there was very little difference among the boats and the entire fleet impressed us with style and handling rarely encountered in other hulls.

Ski Nautique 2001

The boat the test team would like to own is the Correct Craft Ski Nautique. Its combination of soft ride, near-perfect handling and exceptional fit and finish

make the 2001 our test winner. The boat is deeper than most ski boats, a plus for a family, and the windshield is high enough to offer wind protection, yet visibility from all angles is superb.

The boat features a partial deep-vee to the center of the hull and flat outer-hull sections aft. This gives it a soft ride, minimal wake and low spray deflection. At top speeds the boat was exceptionally stable and had no tendency to wander in straightaways or turns.



1. SKI NAUTIQUE 2001

LOA: 18'9" Beam: 84" Wt. 2300 lb. Fuel: 27 gal.
Deck area: 21.19 sq. ft./Seating: 6 adults
Storage: 11.13 cu. ft., hot-air ducts cut bow space
Engine: 351-cu.-in. V8/Gearing: 1:1/Prop: 13x13
Top End: 44 mph/Ranking: 2, tracks straight
Acceleration 0-35: 7.09 sec./Ranking: 3
Performance course: 48.87 sec./Ranking: 2
Handling: Mercedes on water, smooth
Fit-and-Finish: Excellent glass and upholstery work
Price as tested: \$20,000
Address: Correct Craft, P.O. Box 593389, Orlando, FL 32859, (305) 855-4141

2. SUPRA SPORTS COMP TS6M

LOA: 19'7" Beam: 84" Wt. 2200 lb./Fuel: 21 gal.
Deck area: 26.14 sq. ft./Seating: 6 adults, roomy
Storage: 15.75 cu. ft., unique transom storage box
Engine: 351 cu. in. V8/Gearing: 1:1/Prop: 13x13
Top End: 42 mph/Ranking: 5, wanders slightly
Acceleration 0-35: 8.37 sec./Ranking: 6
Performance Course: 49.95 sec./Ranking: 4 (tie)
Handling: Very secure in corners, sports car feel
Fit-and-Finish: Exceptional styling and upholstery
Price as tested: \$19,295
Address: Supra Sports, P.O. Box C, Greenback, TN 37742, (615) 856-3035

3. SUPREME INDUSTRIES SKI SUPREME

LOA: 19' Beam: 83" Wt. 2450 lb./Fuel: 26 gal.
Deck area: 20.52 sq. ft./Seating: 7 adults
Storage: 14.62 cu. ft., opportunities overlooked
Engine: 351-cu.-in. V8/Gearing: 1:1/Prop: 13x13
Top End: 45 mph/Ranking: 1, solid feel
Acceleration 0-35: 6.29 sec./Ranking: 2
Performance course: 47.72 sec./Ranking: 1
Handling: Awesome in turns, hugs water
Fit-and-Finish: Good, but not strong in styling
Price as tested: \$19,995
Address: Supreme Industries, Rt. 4, Box 850, Louisville, TN 37777, (615) 984-7700

High instrumentation for perfect visibility while driving. Stereo a nice touch. Snug, well-padded driver's seat.

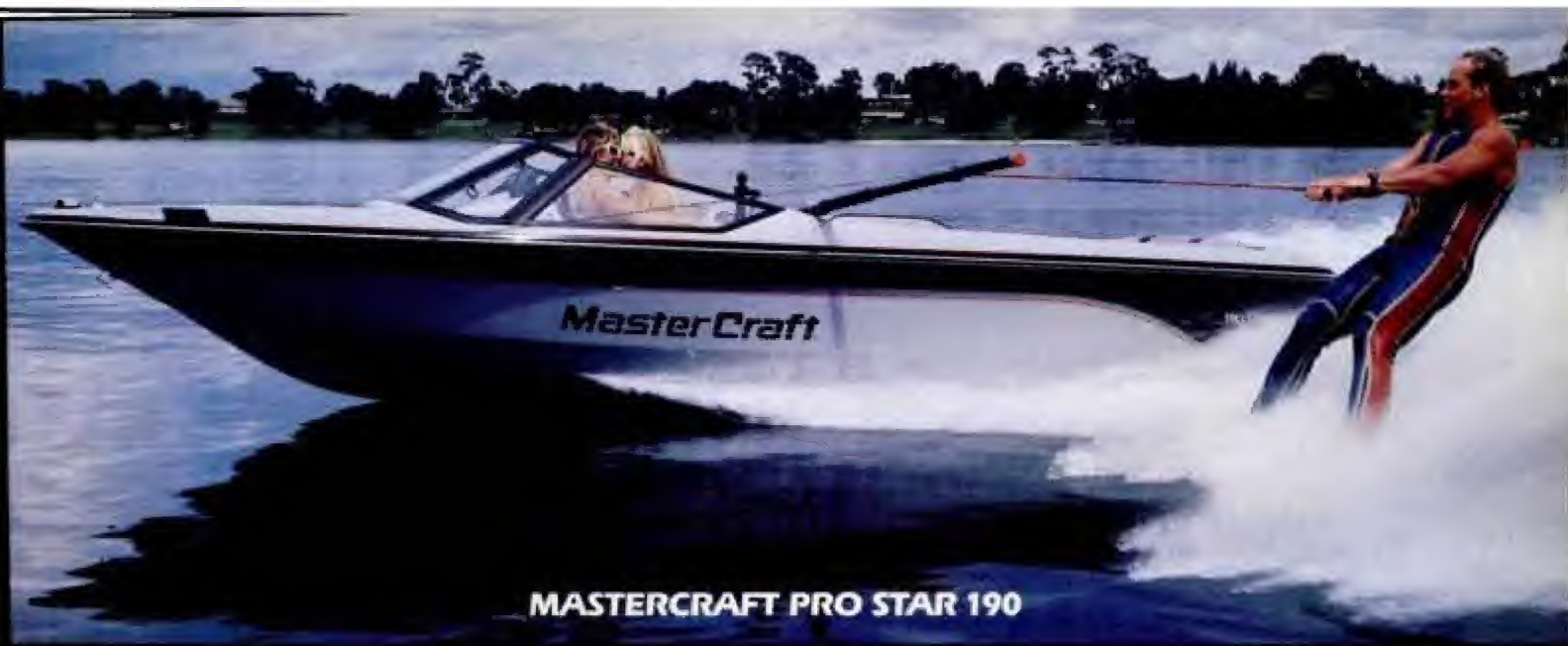


Striking aircraft-style dash puts all gauges in perfect position. Footwell has extra room for long-legged drivers.



Gauges are in fine viewing position, but dash styling is somewhat spartan. Driver's seat isn't as stout as others.





MASTERCRAFT PRO STAR 190

In the cockpit, the well-padded driver's seat is snug and secure, and the racing-style wheel offers a soft, safe grip for tight maneuvers. The analog gauges are all mounted just beneath the driver's line of sight, making them easy to monitor while keeping a sharp lookout. The gauge pod, however, may be a bit too high for shorter drivers and could obstruct forward vision.

We liked the tool box built into the top of the below-decks battery case, and the

foam-insulated ice chest under the forward seat. Another plus is the unique optional heater, which features flexible air ducts that are connected to a hot water pipe from the engine. It can dry off a skier in minutes and extend ski season into early spring and late fall.

The only complaint we had concerned a shortage of storage space. The 2001 ranked fifth in this category, due to hoses and cables filling the bow area on the driver's side.

Supra Sports Comp TS6M

Exceptional styling and comfort, plus a wake that skiers love, make the Supra our No. 2 choice. The hull features a deep-vee entry and unique negative chine forward to knock down spray. The chine and deep-vee terminate about halfway aft and the result is a smooth ride, flat wake and spray that drops

(Please turn to page 154)



4. MASTERCRAFT PRO STAR 190

LOA: 19'/Beam: 80"/Wt: 2200 lb./Fuel: 25 gal.
Deck area: 21.23 sq. ft./Seating: 6 adults
Storage: 28.13 cu. ft.; side pockets a plus
Engine: 351 cu. in. V8/Gearing: 1.5:1/Prop: 14x18
Top end: 43 mph/Ranking: 3 (tie), very smooth
Acceleration 0-35: 7.16 sec./Ranking: 4
Performance Course: 50.93 sec./Ranking: 4
Handling: Tracks and responds beautifully
Fit-and-Finish: Upholstery and exterior superb
Price as tested: \$18,900
Address: MasterCraft Boats, Rt. 9, Box 152, Maryville, TN 37801, (615) 983-2178

5. AMERICAN SKIER ADVANCE

LOA: 19'/Beam: 84"/Wt: 2250 lb./Fuel: 22 gal.
Deck area: 22.16 sq. ft./Seating: 5 adults
Storage: 10.55 cu. ft., more space needed
Engine: 350-cu.-in. V8/Gearing: 1:1/Prop: 13x12
Top end: 43 mph/Ranking: 3 (tie), throttle loose
Acceleration 0-35: 6.41 sec./Ranking: 1
Performance Course: 49.56 sec./Ranking: 3
Handling: Easy to drive in all conditions, a standout
Fit-and-Finish: Interior needs improvement
Price as tested: \$19,053
Address: American Skier, 301 Enterprise Dr., Ocoee, FL 32761, (305) 656-3332

6. SKI CENTURION TRU TRAC II

LOA: 19'/Beam: 80"/Wt: 2250 lb./Fuel: 22 gal.
Deck area: 22.30 sq. ft./Seating: 5 adults
Storage: 24.07 cu. ft., copious, good use of space
Engine: 351-cu.-in. V8/Gearing: 1:1/Prop: 13x13
Top end: 41 mph/Ranking: 6, porpoises in chop
Acceleration 0-35: 7.19 sec./Ranking: 5
Performance Course: 52.54 sec./Ranking: 6
Handling: Unpredictable cornering, steering slow
Fit-and-Finish: Plush interior, strong graphics
Price as tested: \$18,995
Address: Fineline Industries, 455 Grogan Ave., Merced, CA 95340, (209) 384-0255

Dash design attractive, but speedos and tach hidden by wheel. Low windshield offers little wind protection.



Good instrument positioning and forward view. Driver's seat snug and strong, but passengers are somewhat cramped.



Instrumentation easy to read. High windshield and freeboard provide secure helm feeling. Unique visual status display.





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KOSLOW



Мемориал «Возвращенные» от «Ветеранов России»

MAN & MACHINE

Exactly 40 years ago, a veteran test pilot with the right stuff shattered the speed of sound and marked day one of a new age in aviation.



BREAKING THE SOUND BARRIER

BY GEN. CHUCK YEAGER (USAF, Ret.)

The joke was on me.

It was just after sunup on the morning of October 14, 1947, and as I walked into the hangar at Muroc Army Air Base in the California high desert, the XS-1 team presented me with a big raw carrot, a pair of glasses, and a length of rope. The gifts were a whimsical allusion to a disagreement I'd had the previous evening with a horse. The horse won. I broke two ribs. And now, as iridescent fingers of sunlight gripped the eastern mountain rims, we made ready to take a stab at cracking the sound barrier—up 'til that point aviation's biggest hurdle.

The Bell XS-1 #1 streaked past the speed of sound that morning without too much fanfare—broken ribs notwithstanding. And when the Mach indicator stuttered off the scale a bare 5 minutes after the drop

from our mother B-29, America entered the second great age of aviation development. We'd fly higher and faster in the XS-1 #1 in later months and years. Its sisterships would acquit themselves ably as the newly formed U.S. Air Force continued to "investigate the effects of higher Mach number." And Edwards Air Force Base, replacing the name Muroc Army Air Base, would witness remarkable strides in supersonic and even transatmospheric flight.

But with the XS-1, later shortened to X-1, we were flying through uncharted territory, the "ugh-known" as we liked to call it. And as ominous as it seemed to us then, that was the whole point. America was at war with Germany and Japan in December 1943, when a conference was called at the fledgling National Advisory Committee for Aeronautics (NASA's forerunner) in Washington. The subject was how to provide aerospace companies with better information on high-speed flight to improve aircraft design. A full-scale, high-speed aircraft was proposed that would help investigate difficult compressibility and control problems, powerplant

X-1 streaks into a new age (above). Other X-1 views (top left) the rocket plane's B-29 mothership and (lower left) cockpit design. Yeager's X-1 awards and insignia include, from left: Federation Aeronautique Internationale gold medal, Presidential Medal of Freedom and Air Force research patch "Toward the Unknown."

BREAKING THE SOUND BARRIER

issues and the effects of higher Mach and Reynolds numbers. It was thought that a full-scale airplane with a trained pilot at the controls would yield more accurate data than could be obtained in a wind tunnel. And, following the English experience with early air-breathing jet propulsion, the notion of using a conventional jet powerplant was advanced.

Discussions continued through 1944, but winning the war was first on everyone's agenda. It wasn't until March of 1945, the war drawing to a close, that the project picked up momentum. Researchers concluded, however, that jet engines of the period weren't powerful enough to achieve the speeds required. Rocket propulsion was explored—specifically, a turbo pump-equipped rocket fueled by acid aniline made by Reaction Motors, Inc. Delivering 6000 pounds of thrust, the engine was thought capable of boosting an airplane to the fringes of the known performance envelope. Ultimately, the Reaction Motors turbo pump became stalled in development, so another 4-chamber Reaction Motors engine, this one fueled by liquid oxygen and diluted ethyl alcohol, was slated for installation. A pressure system using nitrogen gas provided a basis for fuel delivery. This fallback meant X-1 could carry only half the fuel originally anticipated, but at least the project could move ahead.

With an engine in place, Larry Bell of Bell Aircraft Corp. and Chief Design Engineer Robert J. Woods could proceed on the design of the X-1. It was to be unlike any other airplane designed up to that day. The Germans had experimented with rocket planes in the waning days of the war. The ME-163, with

its HWK 509C engine, was credited with a top speed of around 600 mph. (The ME-262, with two jet engines, was clocked at 527 mph.) But the Bell X-1 would be far superior—with a clean, aerodynamic profile that whispered power even while resting dormant on the tarmac. The nose was shaped like a .50-caliber bullet, and its high-strength aluminum fuselage stood a mere 10.85 ft. high and 30.90 ft. long. Wingspan was 28 ft., wing area 130 sq. ft. Launch weight was 12,250 pounds. Landing configuration was close to 7000 pounds. Inside the X-1's diminutive frame was packed two steel propellant tanks, 12 nitrogen spheres for fuel and cabin pres-



Yeager between flights in the X-1.

surization, three pressure regulators, retractable landing gear, the wing carry-through structure, the Reaction Motors engine, more than 500 pounds of special flight test instrumentation and a pressurized pilot's cockpit. Performance penalties, fuel limits and safety concerns dictated an air launch by a specially modified B-29. (However, I did make a successful ground takeoff on January 5, 1949.)

The Army Air Technical Service awarded the contract for the XS-1 #1 (serial number 46-062) to Bell on March 16, 1945, the first of six in the X-1 series. XS-1 #2 (serial 46-063) was later flight-tested by NACA and was modified to become the X-1E Mach 2+ research plane. The X-1 #3 (serial number 46-

064) had a turbopump-driven, low-pressure, fuel-feed system. It was lost in an explosion on the ground in 1951. The X-1A, X-1B and X-1D were also test flown. The A and D were also lost to propulsion system explosions.

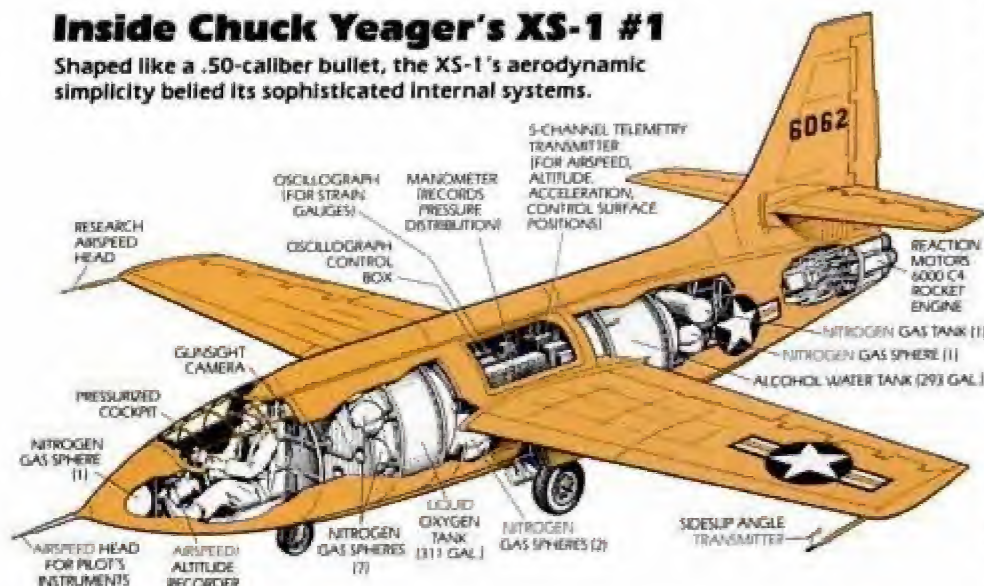
You get the idea that designing, maintaining and—particularly—flying these research tools was not without hazard. But despite the risks, the first X-1 flew like a dream. Its smooth, precise flight characteristics—I remember pulling three slow rolls on the first unpowered flight in midsummer 1947—defined the plane's personality. And as we embarked on the quest to explore aviation's potential, fear, albeit subsurface, supplied a business-like edge to the work. It lurked in the shadows of the psyche as the great B-29, piloted by Maj. Bob Cardenas, lumbered into the crystalline California air with the X-1 clutched to its underbelly. The bomber's gear would come up and the prospect loomed of having to get into the driver's seat of the X-1 "in the usual fashion," as the unemotional post-flight reports described it. It was the worst part of the whole ride—suited more for a contortionist than a pilot. I would stuff my helmet and oxygen mask behind the seat of the X-1 before takeoff, two less items to worry about. At altitude, engineer Jack Ridley and I would stroll back to the bomb bay, trying not to look through the gap between the mother ship and her tiny orange offspring, named *Glamorous Glennis* after my wife, who had happily suffered the standard deprivations as an Army Air Corps wife. It was cold and windy as I made my way to the small steel ladder mounted on slides that would descend to the X-1's cabin door. I'd bounce on it a little and it would drop into position.

Then the fun would start. I'd place my right hand up inside the door and hold on tight to the top of the frame—inches away from all that sky. Then I'd slide in feet first with my left hand still holding the ladder behind my back. I'll never forget that bad moment when I'd have to release my right hand and shift my weight from the ladder to the plane. This was the moment—half in and half out—when I always figured the X-1 would get inadvertently released (crack!) from the cable attachment point overhead. Once inside the plane I'd have to bend around double to turn and slide into the pilot's seat. But it wasn't over. I'd still have to contend with the parachute (as much good as it would do in an emergency) and retrieve my helmet and oxygen mask from behind the seat. When I'd get settled, Ridley would lower the cabin door on a small cable and position it over the door frame. He'd push from the outside and I'd latch from the inside and somehow—in the icy

(Please turn to page 146)

Inside Chuck Yeager's XS-1 #1

Shaped like a .50-caliber bullet, the XS-1's aerodynamic simplicity belied its sophisticated internal systems.



WOODWORKING GUIDE



Build A Roomful Of Mahogany Furniture

■ Dining Table

■ 6 Chairs

■ Sideboard

Plus

■ How To Design Furniture

■ Woodworking Adhesives

■ Guide To Shop Chisels

KEEPING A HIGH-TECH HELICOPTER IN THE AIR STARTS ON THE GROUND.

Every Army helicopter is thoroughly inspected by a small army of highly trained specialists.

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ARMY. BE ALL YOU CAN BE.



Making It Yours, Truly

How to make your next project an original by designing it yourself.

BY THOMAS KLENCK, Associate Editor

So you've decided to build that stereo cabinet for the living room. Or maybe it's time to start thinking about a bed to replace the baby's crib. Your shop is already equipped with most of the tools you need to take on these jobs. It only remains to choose a design. A frantic search through your back issues of POPULAR MECHANICS may offer plans that suit your needs, but what if you want something a little different? The solution lies in designing it yourself.

By creating or modifying the design for a project you gain nearly total control over the finished product. Not only do you experience the personal accomplishment that goes along with constructing a well-made piece, but you've added something of yourself that will be there for years to come. There's little that compares with the satisfaction of watching your idea develop from a few sketches on paper to a tangible object for all to see. The completed piece reflects your input as the designer, making it truly one of a kind.

MAKING IT YOURS

The Importance of drawing

Designing, like building, is a skill that can be learned. As with cutting and fitting wood, it takes practice with the tools of the trade. Design's most powerful tool is drawing. Drawing enables you to try out ideas without going to the time and expense of building them. By drawing, you can visualize what something looks like and how it goes together, or save ideas for future reference.

Many different types of drawing each suit a particular stage in the design process. Drafting, or mechanical drawing, provides a way of producing accurate scale views of an object and is commonly used in shop drawings.

Two types of drafting are orthographic and isometric projection. In orthographic drawing the 3-dimensional object is shown in a series of views: typically, the top, front and side. House plans refer to the front and side views as elevations and the top view is called the plan. Isometric drawing is more pictorial in that it incorporates the three views in one image.

Freehand perspective sketching is a good way to play with ideas in a quick,

fluid format. Here, accuracy is sacrificed to speed. You want to be able to record ideas as fast as you think of them. Freehand drawings are also a good way to show ideas to others. You can easily get an idea of how a corner cupboard would look, for instance, if you photograph the room it is to be in, and trace the photograph with the cupboard drawn in place. Most texts on technical drawing such as *Mechanical Drawing* by French, Svensen, Helsel and Urbanik (McGraw-Hill, 1985) can supply you with detailed information on both drafting and the elements of perspective drawing. For a more in-depth study of freehand perspective take a look at *Architectural Graphics* by James Ching (Van Nostrand Reinhold, 1985).

Begin at the beginning

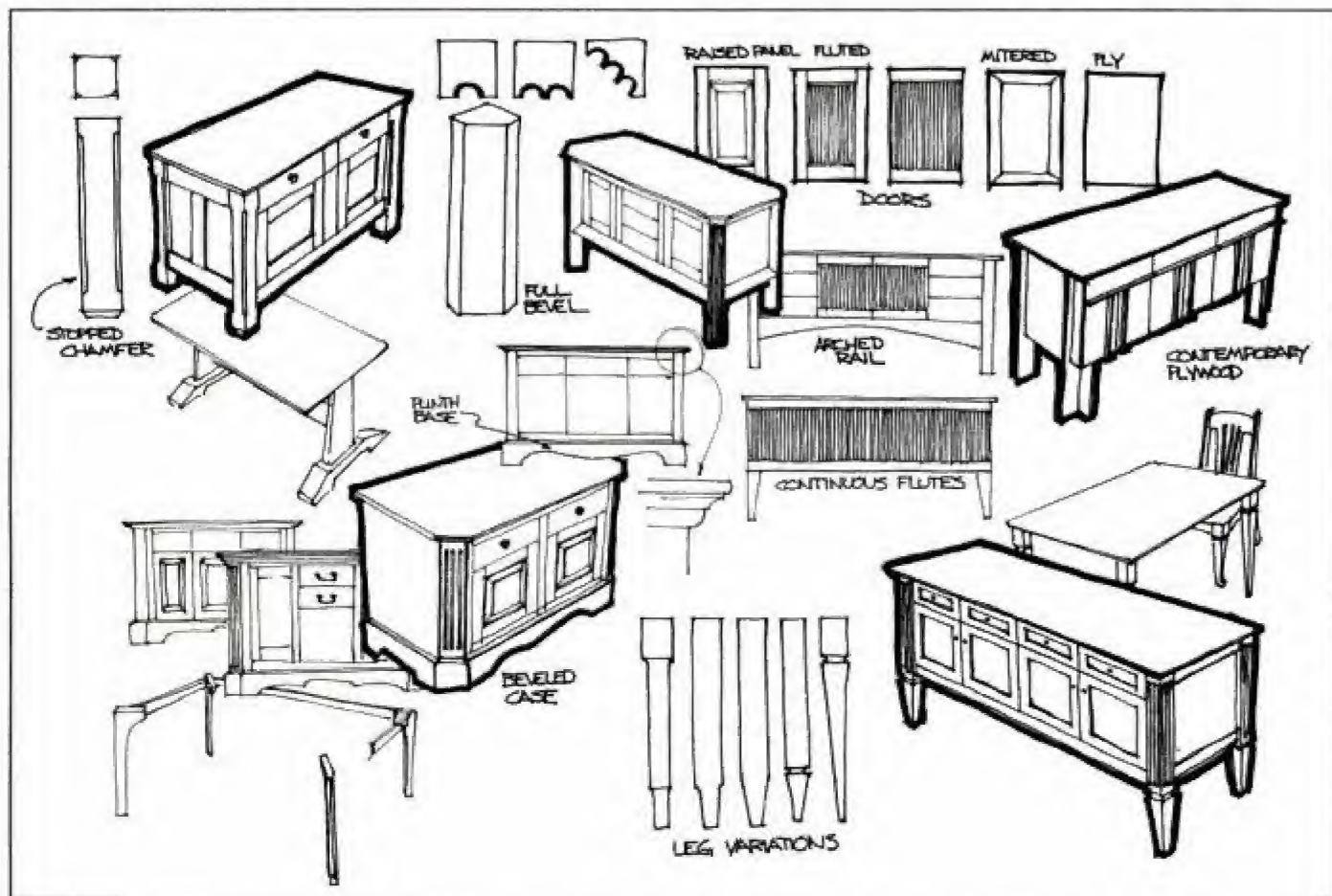
The first step in designing is to define the problem as completely as possible by listing what you want to achieve. Suppose your collection of tools is slowly overwhelming your existing storage space. This is a functional need and prompts a utilitarian solution. On the other hand, the new corner cupboard you're designing might be required to "fit in" with an existing set of furnish-

ings, or be an example of some particular style you like. This nonutilitarian concern is of equal importance.

Begin by listing the functions of the piece. What must it do? What shouldn't it do? For instance, a coffee table should provide a raised surface for supporting magazines and drinks, but it shouldn't be so large as to make part of the room inaccessible.

In designing the three pieces of dining room furniture featured in this issue we began by first determining exactly what we wanted to accomplish. We needed a table large enough to sit six adults comfortably and with enough surface area to contain plates and accessories for a full meal. Our sideboard had to have ample storage for utensils, china and table linens. The chairs, of course, had to be strong enough to support the biggest eaters among our friends and relatives.

Next, list the aesthetic concerns. Try and note the particular way you want the piece to look. If this seems difficult, try instead to note the ways you don't want it to look. Either way you are defining an area that you feel comfortable with. Our dining room furniture had to appear as a set and we decided that the overall design should pay homage to tra-



After defining the problem, begin investigating alternative solutions with quick freehand sketches. Allow each idea to stimulate the next. In these drawings of sideboard designs, we experimented by com-

binning various traditional elements to produce each idea. Designs of a more contemporary nature were noted as well. The final design evolved as a product of these sketches and our initial constraints.

dition but not appear rustic. If possible, we wanted to have some connection to contemporary style while still appearing classically elegant.

The next step is to list all the constraints that will be placed on the design and building of the object. Do you have a limited budget with which to work? How much time can you allocate for the designing and building, and does it have to be completed by a certain date? Do you have the space, tools and skill necessary to complete the job? Can it be finished on site, if necessary, and can you get it through the door or out of the basement? The construction of our dining set was designed to require only the typical portable power tools found in most home workshops. The materials were to be easily accessible and the joinery and detailing in the range of the home workshop enthusiast.

Investigating possibilities

Once the problem has been defined and the constraints noted, you can turn your attention to the creative aspect of design. In this phase, your job is to generate a range of visual ideas from which your final design will be selected. The more ideas the better. Try, at this point,

to forget about the constraints and requirements you have listed and be guided by the broadest possible definition of the problem. You will use these notes later to help you refine your ideas.

Start with a broad functional requirement of the object. A dining table must be a surface that supports food and drink, for example. Now, how many ways can you arrange that? Must the surface be flat? Can it be multileveled? Must it be solid or can it be a framework that contains dishes and glasses? Perhaps it's expandable, or maybe assembled from smaller units. If it's a typical flat surface, how is it supported? Perhaps it hangs from the ceiling to be lowered when needed. Even if you think your ideas go beyond your specific goals, they may lead you to a solution that's appropriate. Furthermore, you may find that certain ideas, while not suitable for the immediate project, relate directly to some other problem that needs to be solved.

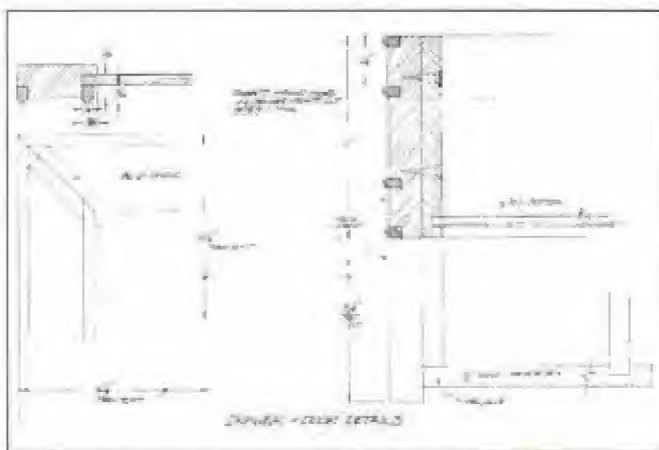
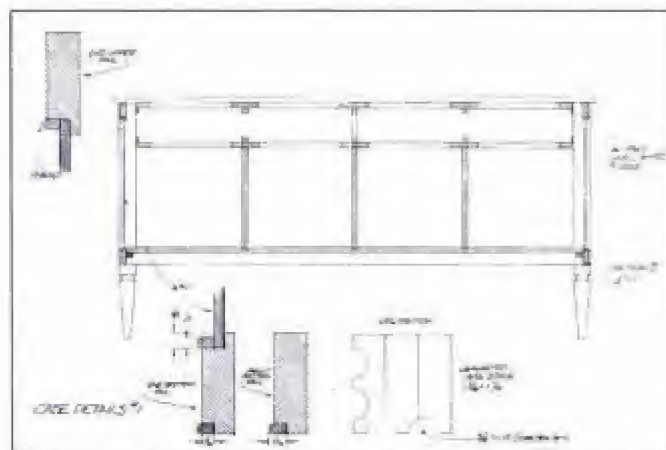
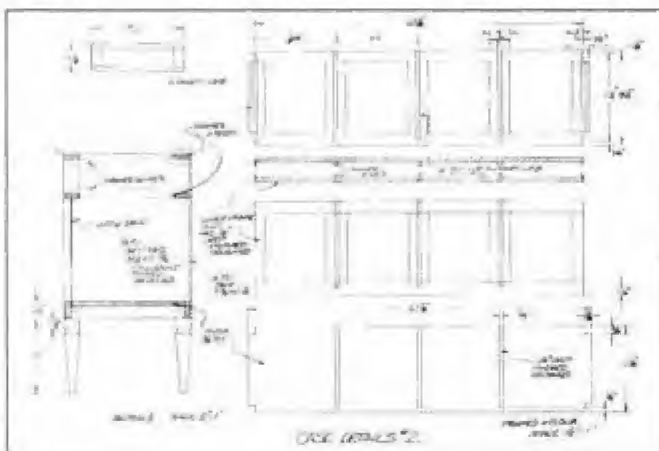
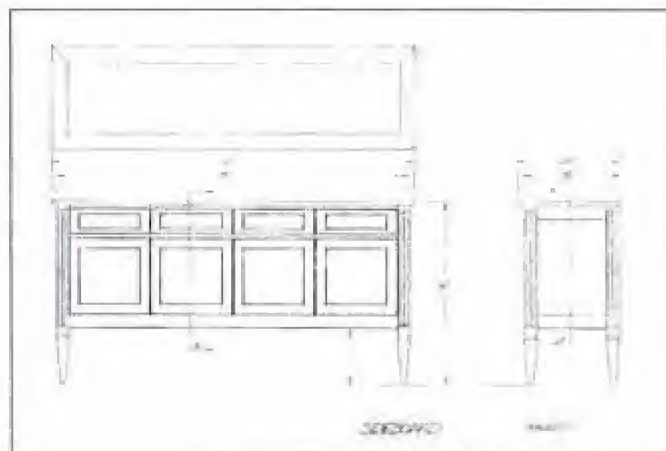
Now consider the aesthetic priorities in the same way. If you have a firm idea as to the styling of the piece, become familiar with existing objects that are similar. Try to isolate the components that give the style its identity. Is it pro-

portioning? A sense of lightness or delicacy? Perhaps it's the geometric nature of the style. Some styles are identified by an attention to detailed ornament while others are clean and simple. After reviewing the components of a style, start drawing alternative ways these elements can be put together. As with functional ideas, don't dismiss them too quickly. When trying to be creative, the worst thing is to be negative.

If you don't have a firm style in mind you can still proceed with this step, but the scope of possibilities will be much wider. Be prepared for ideas that are unfamiliar. Instead of researching existing styles, look to unrelated areas for inspiration. Investigating shapes found in nature is one good way, as is studying other forms. Try and interpret these shapes in your design. Solutions arrived at this way often take some getting used to, don't be afraid to try anything new. Tradition connects us with our roots as well as providing a platform for exploration.

Harmony and discord

Keep in mind that a finished design will be composed of elements that relate to each other visually. The shapes of the



Drafting allows you to develop and refine actual construction details and proportioning. Constraints such as sizes and types of available material, types of tools to be used, construction techniques and ergo-

nom factors all contribute to the final design. Cross sections enabled us to work on the inside and provide a clear description for the builder. Detail views describe door and drawer construction.

MAKING IT YOURS

individual parts should be considered collectively.

If, for instance, you rout a $\frac{1}{4}$ -in. round on the corners of all the pieces of a table, they will be visually connected in the finished piece. The object should convey a theme that is the product of the overall shape and the detailing of the parts. These relationships give the piece a sense of harmony.

The predominant visual theme of our dining set is a simple rectangle. We added two distinct but related motifs in the stopped flutes that appear on the legs and the half-round, $\frac{1}{4}$ -in. beading that define and highlight the frame edges. These ornamental details are connected in that they are both linear elements with semicircular cross-sections. They are different in that the flutes are recessed and appear framed in the legs while the beading frames the drawers and doors and stands proud off the surface. The similarity between these elements tends to hold each piece together while the difference creates visual interest. The three separate furniture designs all employ the same ornamental themes. Each piece, however, varies the details to suit its proportions.

Selecting and refining

Next, evaluate and synthesize the ideas that solve your problem both functionally and aesthetically. Look over your drawings and begin combining ideas from each set to produce complete ideas. Weed out solutions that don't seem appropriate. Ideally you want to end up with one or two designs that satisfy the general requirements.

Now, return to your problem definition and list of constraints. You must evaluate your solutions using the initial set of priorities. Are there places where it falls short? Can it be made within your limitations?

Now is the time to make whatever alterations are necessary to make your idea suitable. You may have to use plywood instead of solid wood. Perhaps it must be collapsible to be transported. Occasionally you find a very attractive idea causes you to change your priorities. Further refinement of your design should occur on the drawing board where exact measurements, proportions and detailing of joints and ornament takes place.

When drafting your design, choose a scale that allows the object to be drawn large enough to show all relevant details. If this isn't possible, draw large-scale detail views. Consult a reference guide such as *Architectural Graphics Standards* for specifications on seat and table height or other necessary data. A good pragmatic way to determine these specifications is to measure pieces that you use regularly and are familiar with. Determine any other dimensional constraints, such as room size, dimensions of items to be stored, and available lumber sizes.

Begin the drafting by drawing the elements that must conform to these standards and judge the variable dimensions to suit your sense of proportion. Don't expect to be satisfied the first time. Use tracing paper to draw overlays which allow you to adjust the finer points of the design. When the form uses complex curves, or other elements where patterns would be useful, draw

the object full size. This is especially useful in chair design.

It's sometimes useful to make a model of the design. Scale models, or mockups, are made at the scale of the drawing or larger and can be constructed out of cardboard, paper or scraps of wood fastened together with hot glue or double-faced tape. These mockups are not intended to be finished products, but only serve to make errors apparent before actual construction.

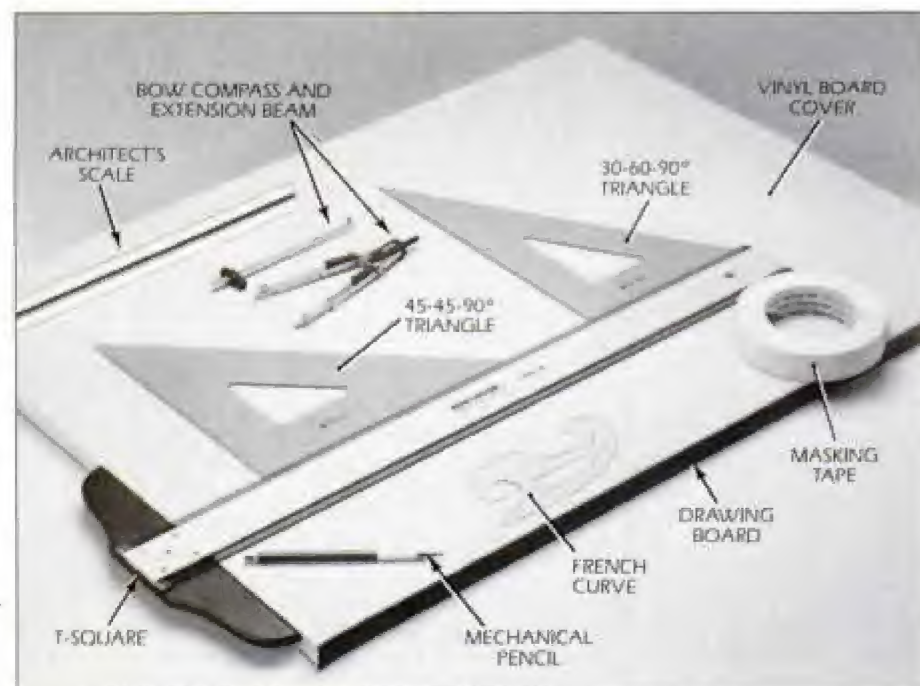
Once you are certain that your drawings are complete, you should create a cutting list. Here, each piece is noted along with the sizes it must be cut and dressed to. This greatly speeds up construction and helps to eliminate cutting errors which mean wasted wood.

There is no one way to go about solving every design problem. Some problems require a great deal of creative exploration while others begin as refinements in a drafting. As both the designer and the builder you have the unique opportunity to make changes to your design during the actual construction. Sketches, draftings and mockups all serve to prepare you for the construction and the appearance of the finished piece. However, there is no substitute for seeing and handling your ideas as they materialize.

The process of the designer-builder is much like the planning that goes into a trip. First, you decide where you're going, investigate all the ways to get there, and be prepared for the unexpected. Then, hop in the car and go.

Remember, good designing anticipates reality. As you practice, you'll become more skillful at seeing things in your mind's eye.

PM



Drafting Equipment

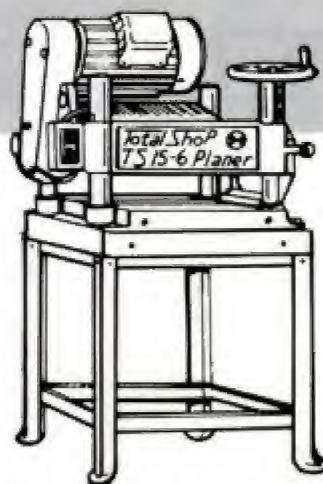
Drafting boards are available in a range of sizes. A 23-in x 31-in. board should be large enough for most projects. To protect the board and provide a smooth surface for drawing, attach a vinyl board cover with double-faced tape. A T-square permits drawing parallel horizontal lines and is used in conjunction with the triangles to produce parallel vertical lines and an array of standard angles. Use an architect's scale to reduce your drawing to a manageable size and a bow compass with beam extension to handle arc and circle drawing chores. For curves that aren't circular, a French curve is useful. Mechanical pencils accept drawing leads or you can use individual pencils of the appropriate grades. Use a 4H pencil for construction lines and save a softer 2H or H pencil for object lines and lettering. Masking tape is best for holding the drawing paper because it reduces tearing when the drawing is removed. Most art supply stores stock the above items.

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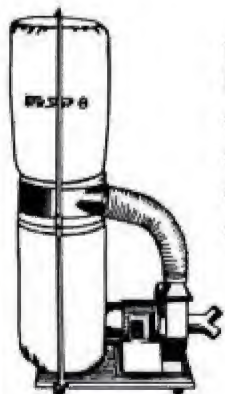
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How Glue Works

A woodworker's guide to workshop adhesives.

BY JOSEPH TRUINI, Shop And Tools Editor, and LEE GREEN
PM Photos by Brian Kosoff

If you're a typical woodworker, chances are you don't spend a whole lot of time thinking about how glue works. Your primary concern is simply that it *does* work. However, understanding the nature of adhesives and how they interact with wood will help guide you in selecting the right glue for each job.

The use of adhesives dates back at least as far as the ancient Egyptians. These original glues, made from animals and vegetables, changed little through the subsequent centuries. During the first half of this century, however, the adhesive industry grew in leaps and bounds. The primary causes for this sudden and rapid growth were the development of synthetic adhesives, a growing plywood industry and the demands of World War II. The adhesive industry has continued to grow and develop steadily up to the present.

Today's adhesives are highly specialized and formulated to meet specific assembly requirements. But, choosing the right adhesive from the wide variety of products now available, can be a little confusing. Presented here are 10 requisite workshop adhesives that will handle virtually all gluing jobs (see the *clip-and-save chart on page 103*). We decided not to try and cover every adhesive on the market. There's no discussion of panel adhesives, silicone, flooring mastic or tile adhesives. Instead, we concentrated only on the best adhesives for use in the workshop. Before getting into the specific uses for each adhesive, let's talk about just how glue works.

Adhesion answers

It would be easy to fill a book with a detailed analysis of the mechanisms of

adhesion—in fact, several such books do exist. In more practical terms, though, the situation is much simpler: glued surfaces bond together at the points where they make contact. This may sound simple, but even a very smooth surface is quite rough on a microscopic level and, therefore, makes contact only on a small percentage of its total area. Glue fills these tiny irregularities and then hardens to form a solid connection or bridge between the glued pieces.

When glue soaks into a wood's porous surface before hardening, it creates a bond known as mechanical adhesion. The strongest holding force in a glued joint, however, is known as specific adhesion. Specific adhesion works by attracting unlike electrical charges that are found in every material. The positive and negative charges in the glue are molecularly attracted to the charges in the workpiece. In practice, both mechanical and specific adhesion can and do occur at the same time.

A successful glue joint also depends on the strength of the solid bridge, the hardened glue itself. This is known as the cohesive strength. The molecular attraction that holds the glue together is cohesion. If that were all there was to it, selecting the best adhesive would be easy—simply pick the glue with the highest cohesive strength. But, as you may have guessed, there's more to it.

Adhesive joints are subjected to a variety of stresses and the highest-strength glue for one type of stress may be a poor choice for another type. Glues are strongest when the forces trying to pull them apart are perpendicular to the glue line (tensile stress) or parallel to it (shear stress); see the drawing on page 102. In both tensile and shear stress, the

force is spread evenly over the entire glue joint.

Conversely, peel and cleavage stress create the weakest glue joint because all the force is applied along the edge of the joint. A glue that produces joints with tensile strengths greater than 1000 pounds per sq. in. (psi) will typically have peel strength values ranging between 10 and 50 pounds per in. along the joint edge. Joint failure under peel or cleavage stress starts with a thin line of failure that works its way back from the edge until the pieces come apart.

Stress to glue joints is also caused by





changes in the temperature. Adhesives and workpieces expand and contract as the temperature rises and drops—but not necessarily at the same rate. If there's a large difference in the degree of expansion and contraction between the adhesive and workpiece, then the glue joint will pull apart. Flexible adhesives are less affected by temperature change than rigid ones.

Favorable features

Besides strength, there are other characteristics to consider when choosing an adhesive. A fast-setting glue, like hot-

melt or cyanoacrylate, lets you assemble small parts very quickly without fussing with clamps. A slow-setting glue, such as hide glue, allows you to work at a leisurely pace which is necessary when building large, complex projects. A disadvantage of slow-setting glues is that the assembly must remain clamped for several hours. This can become a nuisance if you don't own a lot of extra clamps.

Other features to consider include heat and moisture resistance, color when dry and shrinkage. In regard to cost, most glues are relatively inexpen-

sive and, like many items, more economical if bought in large-size containers. Two-part glues, like epoxies and resorcinol, are on the high end of the price scale. For example, resorcinol (32-ounce size) costs about \$20.

Your best insurance for a successful, long-lasting glue joint is printed right on the container. Glue manufacturers provide valuable information, directions and safety precautions on each label. Be sure to read them carefully. Also, additional specifications are often available from the manufacturer. Now let's look at the most common workshop glues.



Here are the 10 most useful workshop adhesives (left to right): white glue, yellow glue, liquid hide glue, hot-melt glue sticks with glue gun,

contact cement, instant-bond glue, resorcinol, 5-minute epoxy syringe, slow-set epoxy and plastic resin. See chart for uses.

Adhesive specifics

■ **White glue** is the most popular household glue sold. Made from polyvinyl acetate (PVA), it's a good general-purpose glue. Use it on porous materials such as paper, leather, wood and wood products. White glue is nontoxic, odorless, nonflammable and it sets quickly (less than 1 hour) and dries clear. It has low moisture resistance so don't use it on outdoor projects or where moisture is a problem. Specially formulated PVAs are available for use by children.

■ **Yellow glue**, also known as carpenter's glue, is an aliphatic resin. This glue is formulated for use on all types of wood and wood products. Like a PVA, yellow glue is water-based, but it sets quicker and has better moisture resistance than white glue. Aliphatic resins have good heat resistance and aren't affected by most common solvents found in varnish, paint and lacquer. Yellow glue dries translucent and is sandable so that it won't clog abrasive paper.

This is also an excellent glue for poorly heated workshops since it can be used in temperatures as low as 45°F. But remember, at lower temperatures a longer curing time is required.

■ **Hide glue** is one of the oldest glues

still in use today. Made from animal hides, hooves and bones, it now comes in easy-to-use liquid form. For purists, hide glue is also available in solid chips that must be liquified in a heated pot before use.

Use hide glue on all types of wood and wood products. Its long setting time is convenient when extra assembly time is needed. Hide glue is very strong but it has poor moisture resistance.

■ **Hot-melt glue** comes in waxy sticks and is applied with an electric glue gun. Glue gun prices range anywhere from about \$7 to \$40 depending on the style. A 2-dozen box of 4-in.-long glue sticks cost about \$5. This is an ideal glue for hobbyists and craftspersons. It sets almost instantly and can be used on nearly all materials including wood, metal, ceramics and cloth. Hot-melt glue comes in several formulas including general-purpose, flexible caulking for use around plumbing fixtures and a new brown-color, wood-tone glue. When using hot-melt glue, avoid applying it to very cold workpieces. The glue doesn't bond well to cold surfaces. **Caution:** Be careful not to touch the glue gun tip during use, it's extremely hot.

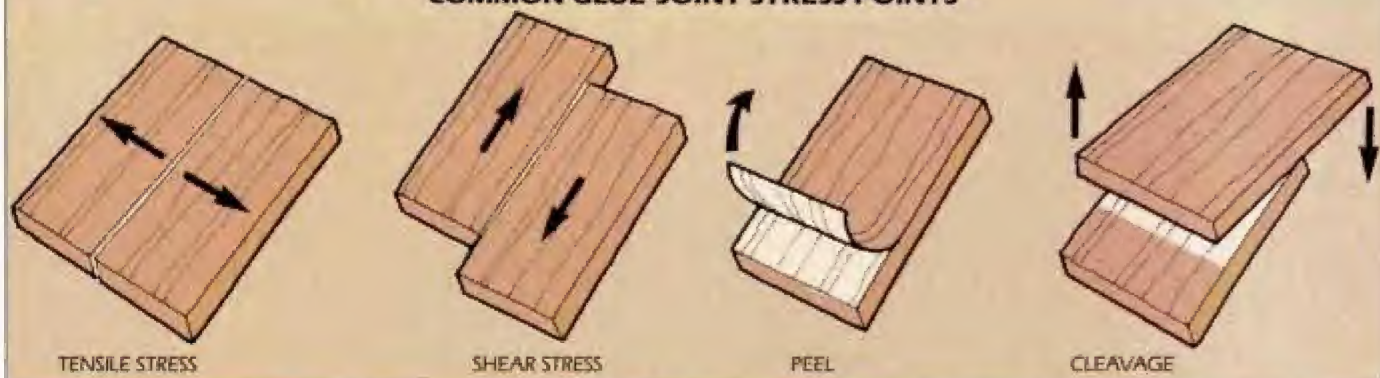
■ **Contact cement** is used primarily for

adhering plastic laminates and wood veneer to a particleboard or plywood core. Apply contact cement to both surfaces with a brush, roller or spray gun. Once the glue is tack-free (about 5 minutes), press the parts together. As its name implies, the cement bonds on contact. There are three types of contact cements available: flammable, nonflammable and water-base.

Solvent-based flammable cement should be used only in well-ventilated areas and never near an open flame, pilot light or running electric motor. The advantages to using flammable cement is that it dries very quickly and is the cheapest of the three types. Nonflammable cement is the most expensive and ventilation is needed during use, but it dries quickly and is safe near open flames. Water-base contact cement is medium-priced and extremely safe to use. It's nontoxic and nonflammable. One major drawback, however, is that it has a painstakingly long drying period—often up to 1 hour. Don't use water-base contact cement on metal surfaces. It could cause corrosion.

■ **Instant-bond glues** are more commonly known by such trade names as Krazy Glue and Super Glue. These re-

COMMON GLUE-JOINT STRESS POINTS



This illustration shows four of the many types of stress exerted on glue joints. Tensile stress pulls perpendicular to glue line. Shear stress

moves parallel to it. With peel and cleavage, failure starts at joint edge and works its way back across the surfaces.

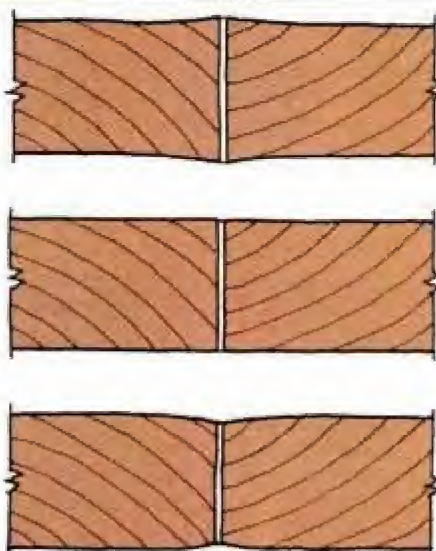
markedly strong, superquick-setting glues are cyanoacrylate (cyanogen and acrylic resins) adhesives. Cyanoacrylates work very well on nonporous materials such as glass, metal, ceramics, jewelry and many plastics. Certain thickened, gel-type cyanoacrylates can also be used on porous surfaces such as wood and paper.

One small drop is all that's required for most repair jobs, so use it sparingly. These glues also bond skin instantly so use them carefully. Use acetone or nail polish remover to dissolve hardened cyanoacrylate.

■ **Resorcinol** is a 2-part resin that dries completely waterproof. And, it's arguably the strongest wood glue available. One minor drawback is that resorcinol dries reddish-brown in color.

It comes in two cans: a powdered catalyst in one can and a liquid resin in the other. Measure the two parts in separate containers to avoid contaminating either can and mix them thoroughly on a scrap board with a putty knife. Wear eye goggles and a respirator while mixing resorcinol as protection against the catalyst dust. Use resorcinol on all outdoor projects and marine applications.

■ **Epoxies** are available in two basic types: 5-minute fast-set, and slow-set. Epoxies are noted for their high strength and the ability to bond a wide variety of materials. Fast-set epoxy is most often sold in a double-barrel syringe. One barrel contains the resin and



As wood absorbs glue, it swells slightly (top). If the wood is surfaced flat before glue cures fully (center), a sunken joint will result when the wood finally dries out (bottom).

the other is filled with the hardener. Push the plunger to dispense equal amounts of each ingredient. Mix the glue thoroughly before use. It sets in about 5 minutes but cures in 12 to 24 hours.

Slow-set epoxy comes in two separate containers—usually squeeze bottles or cans. It can sometimes be found in syringe containers, too. Use slow-set epoxy when you need more time to work before the glue sets. Mix equal amounts of resin and hardener on a scrap board

with a putty knife. As with all 2-part glues, mix only enough adhesive as you can use in one application. Slow-set epoxy usually sets in about 30 minutes but it can take up to 4 hours depending on the temperature.

■ **Plastic-resin** is a urea-formaldehyde powder that, when mixed with water, becomes a powerful wood glue that is both heat and moisture resistant.

Although plastic resin has a long setting time (12 to 14 hours), it's a favorite of cabinetmakers because of its long pot life (about 4 hours), high strength and nearly invisible glue line. **PM**

Adhesive Manufacturers List

- Borden Chemical Corp., 180 E. Broad St., Columbus, OH 43215
- Devcon Corp., 30 Endicott St., Danvers, MA 01923
- Dow Corning Corp., Midland, MI 48667
- Duro (Loctite Corp.), 4450 Cranwood Ct., Cleveland, OH 44128
- Franklin International, Chemical Div., 2020 Bruck St., Columbus, OH 43207
- General Electric, Silicone Products Div., Watford, NY 12188
- H.B. Fuller, 315 South Hicks Rd., Palatine, IL 60067
- Krazy Glue Inc., 53 W. 23rd St., New York, NY 10010
- Maccos Adhesives, SCM Corp., P.O. Box 230, Wickliffe, OH 44092
- Macklanburg-Duncan (M-D), Box 25188, Oklahoma City, OK 73125
- Magic American Chemical Corp., 23700 Mercantile Rd., Cleveland, OH 44122
- Miracle Adhesive Corp., P.O. Drawer D, Bellmore, NY 11710
- Roberts Consolidated Industries (Weldwood), P.O. Box 1250, Industry, CA 91749
- Super Glue Corp., 184-08 Jamaica Ave., Hollis, NY 11423
- 3M Co., Home Products Div., Building 223-4S-1, 3M Center, St. Paul, MN 55140

WORKSHOP ADHESIVES

ADHESIVE	WHITE GLUE	YELLOW GLUE	LIQUID HIDE	HOT-MELT	CONTACT CEMENT	INSTANT-BOND	RESORCINOL	EPOXY 5-Minute Slow-set	PLASTIC RESIN
Base Material	polyvinyl acetate	aliphatic resin	animal hides, hooves, bones	thermo-plastic resin	synthetic rubber	cyanoacrylates	resorcinol resin	epoxy and polyamine resin	urea formaldehyde
Setting Time*	30-60 mins.	20-45 mins.	12-16 hrs.	10-45 secs.	bonds on contact	10-30 secs.	10-14 hrs.	5-10 mins. 2-4 hrs.	12-14 hrs.
Curing Time	24 hrs.	24 hrs.	16-24 hrs.	1 min.	24 hrs.	2-4 hrs.	24 hrs.	12-24 hrs.	14-24 hrs.
Strength	high	high	high	medium	medium	very high	very high	very high	high
Clamping Required	yes	yes	yes	no	no	no	yes	yes	yes
Moisture Resistance	poor	fair	poor	high	good	fair	excellent (waterproof)	good	very good
Heat Resistance	poor	good	excellent	poor	good	fair	good	good	good
Color When Dry	clear	translucent	amber	clear, white or brown	amber	clear	reddish brown	clear, white or gray	light tan
Minimum Ambient Temperature *F	60°	45°	70°	apply with electric glue gun	70°	40°	70°	70°	70°
Best Uses	wood, paper, cloth, leather	wood and wood products	wood and wood products	wood, metals, plastics, ceramics, paper, cloth	plastic laminates and wood veneer to wood, plywood, and particle-board	ceramics, metals, wood, plastics, rubber	wood and wood products	metals, glass, ceramics, marble, wood	wood and wood products

*Setting time refers to the amount of time an adhesive needs to harden enough so that you can remove the clamps. Curing time indicates the approximate time you should wait before putting the glued workpiece to use. Curing time does not indicate when an adhesive has cured 100 percent. Most glues continue to cure for several days before reaching full strength. For best results, always read and follow the manufacturer's instructions printed on the glue container.

Chisels

Here are the finest chisels available from around the world.

BY JOSEPH TRUINI, Shop And Tools Editor; PM Photos by Brian Kosoff



To call a chisel a simple tool is an understatement of colossal proportions. Even though its design is simple, it's essential for most types of do-it-yourself work. In fact, no toolbox or workshop is complete without an assortment of chisels.

The chisels collected here represent a wide range of styles and sizes to suit all

work. Some are general-purpose chisels while others are specially designed for specific jobs such as cleaning out the bottom of a deep mortise, trimming a dovetail joint, or shearing off a bolthead. Note that the chisels have either a wood or plastic handle, or feature all-steel construction such as No. 5 and No. 15. Generally, wood-handled chisels should be struck only with a wood or plastic

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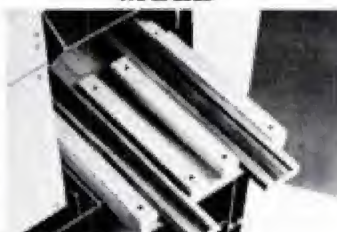
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mallet. Plastic-handled chisels can be hit with a mallet or hammer. Strike an all-steel chisel with a ball-peen or small sledge hammer. In *all* cases, be sure to wear eye protection.

As with most hand tools, a chisel is easiest to use and most effective when it's sharp. Wood chisels are usually factory-ground to a 25° to 30° bevel. A secondary bevel is then honed on the blade to form the actual cutting edge. Some chisels come honed and ready to use. Others are ground only and you must hone them before use. Keep your chisels honed with a hard Arkansas sharpening stone or a Japanese waterstone. Also, invest in a honing guide. This simple tool will hold the chisel at the correct angle for accurate honing.

Japanese chisels

Traditional Japanese wood chisels have two unique features. First, the chisel's blade is made of laminated steel.

Very hard high-carbon steel forms the bottom layer and cutting edge of the chisel. The rest of the blade is made of softer steel that provides strength and resiliency. Laminated construction saves valuable hard steel and makes sharpening easier since only the cutting edge is hard steel.

Another unique feature is that the blade's back surface is hollow ground. Some Japanese chisels have a single, full-width hollow that is similar to a very shallow spoon. Other chisels, like No. 14, have a multiple-groove back with two, three or four shallow hollow-ground grooves. The number of grooves depends on the width of the chisel blade. According to Henry Lanz, author of *Japanese Woodworking Tools: Selection, Care And Use* (1985 Sterling Publishing, 2 Park Ave., New York, NY 10016, \$12.95), the purpose of hollow-ground chisels is probably to make it easier to grind the back surface perfectly flat. Since there's less back surface to



grind, you save both time and wear on the sharpening stone.

Chisel tips

To use chisels skillfully requires only a little practice to acquire the proper "feel." Chisels can be used bevel up or bevel down. Whenever possible, chisel with the "uphill" direction of the wood grain. Otherwise, the chisel might dig in. The most common mistake is trying to remove too much stock at once. Overdriving a chisel will only dull the tool and ruin the work. Always store your chisels carefully to prevent chipping the cutting edge. Inexpensive, slip-on plastic tip protectors are available for most size chisels.

Now let's take a look at the 19 chisels shown here.

1. Blue chip bevel-edge chisel—The 1-in.-wide English-made tool shown is an excellent general-purpose chisel. It features a virtually indestructible polypropylene handle and

quality forged tool-steel blade. The no-roll handles are square with rounded corners for a comfortable grip. A set of five chisels— $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 in.—costs \$43.80 from Constantine's, 2050 Eastchester Rd., Bronx, NY 10461.

2. Swan-neck mortise chisel—Forged from square bar stock, this unusual-looking tool is extremely helpful in smoothing out the bottom of mortises. The curved blade is used like a lever to scrape the mortise bottom flat. It can be used in mortises up to 6 in. deep. A steel hoop on the wood handle helps prevent it from splitting. The German-made 10-mm chisel shown costs \$16.95 from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

3. Cranked-neck paring chisel—Looking somewhat like a narrow trowel, this tool has a $1\frac{1}{4}$ -in.-wide \times 8-in.-long blade and an offset handle. This design allows you to make light, finishing cuts with the blade flat on the stock—even when

CHISELS

working in the middle of a wide board. It's available in five sizes ranging from 1/4 in. to 1 1/4 in. The chisel shown costs \$51.95 from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

4. Mortise chisel—Unlike a standard chisel, the blade of this tool has straight, nonbeveled edges identifying it as a mortise chisel. It's designed to take heavy pounding and prying. Features include a thick, hardened-steel blade and an ash handle with a steel hoop at each end to deter splitting. A leather washer between the blade and handle acts as a shock absorber. The 1/2-in. chisel shown costs \$17.10 from Constantine's, 2050 Eastchester Rd., Bronx, NY 10461.

5. Construction chisel—Here's a chisel that's specifically designed for rough carpentry, framing and construction work. It's American-made from a single piece of hand-forged alloy steel and available in seven sizes ranging from 1/4 in. to 2 1/4 in. A set of four (\$29.50) includes 1/4-, 1/2-, 3/4- and 1-in. chisels. Woodcraft, 41 Atlantic Ave., Box 4000, Woburn, MA 01888.

6. Bevel-edge chisel—Anyone interested in quality cabinetmaker's tools should check out Freud's line of bevel-edge chisels. The tools feature chrome-vanadium steel blades and double-hooped boxwood handles. Boxwood is considered to be the best wood for tool handles because of its strength and shock absorbing qualities. They're available in sizes from 1/4 in. to 1 1/2 in. and sold in 4-piece (\$25), 6-piece (\$45) and 10-piece (\$65) sets. Freud, 218 Feld Ave., High Point, NC 27264.

7. Mortise hook chisel—This traditional Japanese chisel has a harpoon-like tip. Use it to make light finishing cuts on delicate pieces and hard-to-reach areas—especially narrow mortises. It can be used on the push and pull stroke. The tip is 3/16 in. wide. It's \$15.95 from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

8. Gilt-edge chisel—From the English toolmaker Robert Sorby, comes this craftsman-quality chisel. Features include a rosewood handle, brass bolster and a diamond-honed steel blade. A set of five chisels—1/4, 3/8, 1/2, 3/4 and 1 in.—with plastic tip protectors costs \$77.45 from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

9. Japanese dovetail chisel—Like most traditional Japanese chisels, this one is made of laminated steel with a hollow-ground back. However, the blade's triangular cross-section is designed for shaping sliding dovetail joints. It's also helpful for cleaning out

long, narrow grooves and tight, inside corners. The 24-mm chisel shown costs \$33.30 from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

10. Corner chisel—Cut clean, sharp, inside corners with this German-made tool. The hand-forged alloy steel blade forms a 90° angle and measures 1/2 x 1/2 in. The blade is fitted into an octagonal hornbeam handle. Costing \$32.50, this chisel is reserved for the serious woodworker and enthusiastic tool collector. Contact Woodcraft, 41 Atlantic Ave., Box 4000, Woburn, MA 01888.

11. Bahco bevel-edge chisel—This Swedish-made chisel is ergonomically designed for superior balance and cut-

in.—is \$122.50. Woodcraft, 41 Atlantic Ave., Box 4000, Woburn, MA 01888.

14. Japanese bevel-edge chisel—This is easily one of the finest chisels I've ever used. Features include a laminated steel blade and hooped boxwood handle. Its 7-in.-long blade provides superior control. Note that both the beveled and back surfaces of a 30-mm chisel are shown to reveal the multiple-groove, hollow-ground back. It's available in eight sizes ranging from 3 mm to 36 mm. The 30 mm costs \$54.95 from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

15. Cold chisel—This all-steel chisel is used to cut through metals that are softer than its hardened cutting edge. Made of double heat-treated chrome-vanadium steel, this 7/8 x 7 1/2-in.-long, tough tool will shear through bolts, nails, screws and sheetmetal. Strike cold chisels with a ball-peen hammer and *always* wear eye goggles. The chisel shown costs about \$6.50 at most Sears stores. A 3-piece cold chisel set—1/4, 3/8 and 1/2 in.—costs about \$8.50. Contact Sears, Sears Tower, Dept. 703—PM, Chicago, IL 60684.

16. Stanley wood chisel set—Here's a good, basic set of chisels for general woodworking and light carpentry work. The set includes six Stanley Professional wood chisels—1/4, 1/2, 3/4, 1, 1 1/4 and 1 1/2 in.—in a convenient plastic storage tray and stand. Each chisel features an impact-resistant plastic handle with a steel cap and high-quality steel blade. The 6-piece set costs about \$60 at stores. Stanley Tools, 600 Myrtle St., New Britain, CT 06050.

17. Dogleg chisels—Basically woodcarvers' tools, these small-scale chisels are ideal for fine cabinet work such as mortising locks and hinges. The 3/16-in.-wide x 1 1/4-in.-long blades are offset to permit proper tool clearance. The set includes a straight-blade, right-hand skew and left-hand skew chisels. It's \$18.95 from Woodcraft, 41 Atlantic Ave., Box 4000, Woburn, MA 01888.

18. Flooring chisel—Also called an electrician's chisel, this all-steel tool has a double-beveled 2 1/4-in.-wide blade. It's used primarily to rip up old wood strip flooring. Electricians use this style chisel to notch house framing when installing cable and electrical boxes. It costs about \$14. Stanley Tools, 600 Myrtle St., New Britain, CT 06050.

19. Brick set—Use this all-steel chisel to score, cut and trim bricks and concrete blocks. This type of chisel should be struck only with a small sledge or ball-peen hammer—not a bricklayer's or nail hammer. It features a 3 1/2-in.-wide blade and costs about \$14 at hardware stores. Contact Stanley Tools, 600 Myrtle St., New Britain, CT 06050. **PM**



ting control. The oval-shaped polypropylene handle is grooved for a comfortable, nonslip grip. The hardened-steel blade comes with a plastic tip protector. The 20-mm chisel shown costs \$15.40. A set of four—6, 12, 20 and 25 mm—costs \$57.50. Contact Woodcraft, 41 Atlantic Ave., Box 4000, Woburn, MA 01888.

12. Skew-ground chisel—Designed for making light finishing cuts, this unique chisel is ground to a 60° angle. Use it to clean up sliding dovetails and other hard-to-reach joints. The thick steel blade is fitted with a tough cellulose acetate handle. The tool is sold in pairs with a right-hand and left-hand skew. A 1-in. pair of skew-ground chisels costs \$22.65 from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

13. Socket firmer chisel—Firmer chisels are designed for heavy-duty work such as timber framing. The tool shown (\$41) has a 2-in.-wide x 8-in.-long blade that tapers from 7/16 in. thick at the shoulder to 3/16 in. thick at the bevel. A hooped ash handle fits into the blade's socket. A 4-piece set—1/4, 1, 1 1/2 and 2

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Fine Dining

This rich mahogany dining table seats six and makes any meal a pleasure.

BY ROSARIO CAPOTOSTO, Contributing Editor

Few activities better illustrate our need to socialize than our dining rituals. Not only are these the times when families get together to discuss the day's events, but they are also the way we choose to accept friends and relatives into our homes. That makes the dining room of central importance to both domestic and social life. And perhaps because of this, it's the one room where most homeowners make a definite effort to assemble coordinated pieces of furniture. And, whether it's Early American, French Provincial or contemporary, the overwhelming material of choice is wood.

In the following pages, we offer you a fine example of coordinated design in our rich mahogany dining set. Beginning with the dining table we'll not only show you how to build the pieces, but also how to accomplish the whole job with ordinary portable power tools. You don't need any expensive stationary shop equipment. The detailing, that may look complicated at first glance, was all designed to be executed with the aid of several specialized jigs that we'll show you how to build. By utilizing similar design details throughout the set, the same jigs can be used for each piece with only minor modifications. Just remember that the base dimensions of routers and circular saws vary from one make to the next, so you'll have to determine the exact placement of the fences and stops on each jig to suit your tool.

If you intend to make the complete set of three pieces, it's more efficient to organize all similar operations so they can be done collectively. You'll need a sabre saw, router, finishing sander, drill and a circular saw with a cutting depth of at least 2½ in. For accurate boring, have a drill guide and doweling jig on hand.

Starting the table

The 2⁷/₁₆-in.-sq. stock for the table legs is made by gluing up three layers of commonly available 1³/₁₆-in. lumber. If possible, use boards wide enough to get more than one leg from each lamination. Because you'll be hand planing the surfaces smooth, try to keep the grain orientation of each board the same before gluing. If you find it hard to judge the grain direction by looking at the board, make a trial pass with your plane. Keep in mind that mahogany can vary in color when selecting boards for each leg. Mark all pieces as to grain direction and stacking order so you won't mix them up during assembly.

Ordinary white or yellow carpenter's glue is fine for making the leg laminations. Use a roller or squeegee to apply it fast and evenly. To keep the boards aligned during assembly, insert a pair of headless nails in the top and bottom boards of each lamination in an area that will become waste. Special double-pointed brads are available for this purpose or you can snip off the ends of small brads and insert them with pliers. Clamp and let dry.



Classic detailing is the main course in our exquisite mahogany dining room table. Delicately spiced with flutes, coves and bead molding, it stands out as an example of refinement and good taste. If you think that you need expensive machinery to build the table, think again. We'll show you how to do it using a selection of portable power tools common to most home workshops, and specially designed jigs to speed you through repetitive tasks.

Table design: Thomas Klenck, Associate Editor
Black-and-white photos: Rosario Capotosto
Technical art: Eugene Thompson
Color photo: J.R. Rost
Photo stylist: Gabe Henick

POPULAR MECHANICS • NOVEMBER 1987



After the glue has set overnight, clamp the laminated stock to the worktable with a straightedge guide positioned on top for guiding the circular saw. Keep a scrap plywood panel underneath so you won't cut into your bench. Use a sharp blade for this cut—preferably one that's designed for ripping.

A detail that appears throughout the dining set is the horizontal cove on the legs. To cut this you'll need a $\frac{3}{8}$ -in.-rad. corebox bit mounted in the router. Build a jig (see page 113) to guide the router squarely across the leg faces at the ap-

propriate distance from the end. Then cut the $\frac{7}{16}$ -in.-deep cove on each face of every leg.

Next, construct the leg tapering jig and secure a rip fence to the base of the circular saw with two bolts as shown in the drawing. The saw base rides on a rail that's the same height as the leg thickness. You can plane a piece of 1-in. stock to $\frac{15}{16}$ in. and nail it to a 2x4 ($1\frac{1}{2} \times 3\frac{1}{2}$ in.) to get the correct height. Note the nail in the end stop block of the tapering jig. A corresponding hole centered in the bottom of each leg allows

you to pivot the leg so it's positioned correctly for cutting each face. When the leg tapers are completed, use a sharp smoothing plane to dress all rough-sawn surfaces.

The vertical fluting that appears on the two outward surfaces of each leg is also cut with the corebox bit. Construct the flute routing jig and use a spacer that can be shifted from one side to the other for uniform flute spacing. Set the fences so the flutes are $\frac{7}{16}$ in. in from the leg corner. A plunge router is ideal for this stopped fluting. If yours is the regu-

FINE DINING

lar fixed type, build your jig with higher sides and carefully lean the router into the wood at the start of each cut. Complete the legs by cutting a stopped chamfer on the inside corner of each leg with a router and chamfering bit. This simplifies boring the lagscrew hole for the corner block.

Making the apron

Rip each apron piece to width, dress the sawn edges and cut to exact length. The joints that connect the rails to the legs are doweled. A completely adjustable doweling jig is better than the self-centering type because many of the joints require off-center holes. Use dowel centers to transfer the hole locations to the legs. The tabletop is fastened to the skirt by 3-in. No. 10 f.s. screws. Counterbore $\frac{3}{16}$ -in.-dia. holes in the bottom edge of each rail for recessing the heads. Then bore $\frac{3}{16}$ -in.-dia. pilot holes through the rails for the screws. The rails on all the pieces in the dining set are highlighted with a $\frac{1}{4}$ -in. bead set into a rabbet. Cut the rabbets with a straight bit mounted in the router and

edge guide. Don't be tempted to use a piloted bit in lieu of the edge guide as the pilot will fall into the counterbores and ruin the cut.

You can make the bead molding with your router and two special cutters. A $\frac{1}{8}$ -in.-rad. half-round cutter produces the profile and a slotting cutter with a pilot rips the trim to thickness. To make this molding, first install the half-round bit in the router so its cutting arc is flush with the router base. Then, working with the router base first against one face, and then the opposite face, cut twin half-rounds on one edge of the $\frac{13}{16}$ -in.-thick stock. Then, install the slotting cutter in the router. Adjust it so it's tangent to the bottom of the half-rounds already cut and rip slots along the bottom of each bead. Finally, use your circular saw guided by a straightedge to rip the two lengths of beading away from the stock. Use a wide board for making this trim. After each pair of beads are cut off, plane the rough sawn edge true and make another set.

Constructing the top

Both the table and the sideboard feature tops assembled from a mahogany ve-

neer plywood panel and surrounded by a solid wood frame. Again, if you're making both pieces, it's more efficient to construct both tops at the same time. Begin by cutting the plywood for the tabletop panel square and to exact size. Use your circular saw with a sharp, fine cutting blade guided by a straightedge.

MATERIALS LIST—DINING TABLE

Key	No.	Size and description (use)
A	4	$\frac{27}{16}$ x $\frac{27}{16}$ x $28\frac{1}{16}$ mahogany (leg)
B	2	$\frac{13}{16}$ x $\frac{13}{16}$ x $64\frac{1}{2}$ mahogany (long apron)
C	2	$\frac{13}{16}$ x $\frac{13}{16}$ x $28\frac{1}{2}$ mahogany (short apron)
D	2	$\frac{13}{16}$ x $\frac{13}{16}$ x $30\frac{1}{4}$ mahogany (cross rail)
E	4	$\frac{13}{16}$ x $\frac{13}{16}$ x 4 mahogany (cleat)
F	4	$\frac{13}{16}$ x $\frac{13}{16}$ x $7\frac{1}{4}$ mahogany (brace)
G	2	$\frac{13}{16}$ x $\frac{13}{16}$ x 36 mahogany (end frame)
H	2	$\frac{13}{16}$ x $\frac{13}{16}$ x 72 mahogany (side frame)
I	1	$\frac{3}{4}$ x 30 x 66 mahogany (top panel)
J1*	2	$\frac{1}{4}$ x $\frac{1}{16}$ x $64\frac{1}{2}$ mahogany (beading)
J2*	2	$\frac{1}{4}$ x $\frac{1}{16}$ x $28\frac{1}{2}$ mahogany (beading)
K**	1	$\frac{1}{2}$ x $\frac{1}{2}$ plywood (spline)
L	8	$\frac{13}{16}$ x $\frac{13}{16}$ x 3 mahogany (glue block)
M	2	$\frac{1}{16}$ x $\frac{13}{16}$ x 30 mahogany (shim)
N	4	$\frac{3}{4}$ x $3\frac{1}{2}$ lagscrew and washer
O	18	3" No. 10 f.s. screw
P	16	$1\frac{1}{4}$ " No. 10 f.s. screw
Q	4	4d common nail
R	16	$\frac{3}{8}$ "-dia. x $1\frac{1}{2}$ " dowel

Misc: Glue, 120- and 220-grit sandpaper, $\frac{1}{2}$ " wire brads, Benjamin Moore Red Mahogany Stain, and McCloskey's Satin Polyurethane Varnish.

* $\frac{1}{4}$ " half-round bit (stock No. 41, \$49) and $\frac{1}{4}$ " x $1\frac{1}{2}$ "-dia. slotting bit (\$25) available from Zac Products, Inc., 34 Renwick St., New York, NY 10013. Add \$3 for shipping.

** 18 linear ft. required.



1 Select leg stock for color and grain orientation and insert headless brads to keep boards aligned during assembly.



2 Use a roller to spread the glue fast and evenly. Make sure the brads are placed in waste area of stock. Clamp until dry.



3 To rip legs, clamp the laminated leg stock to the worktable with straightedge guide on top and scrap the plywood underneath.



4 Horizontal coving jig guides the router squarely across each face of the leg. Use a $\frac{1}{4}$ -in.-dia. corebox bit.



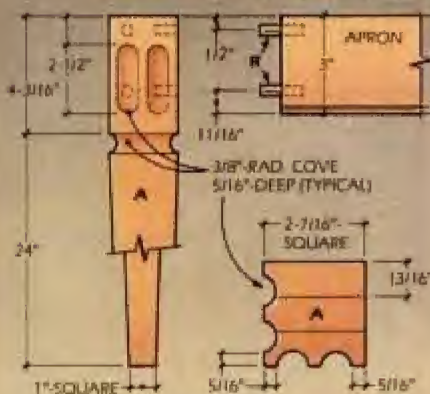
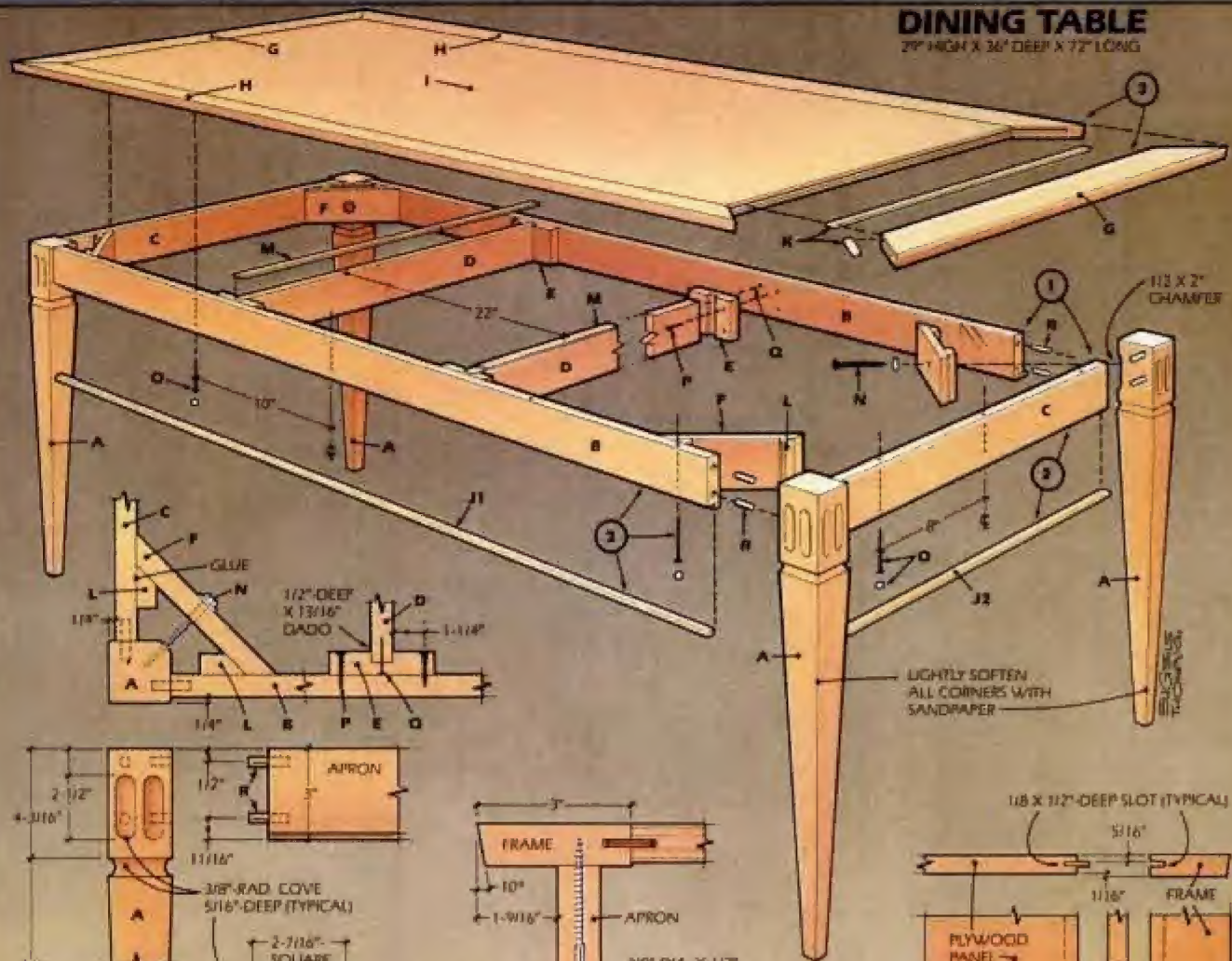
5 Construct a tapering jig to cut uniform tapers on all leg sides. Then, dress all rough-sawn surfaces with a hand plane.



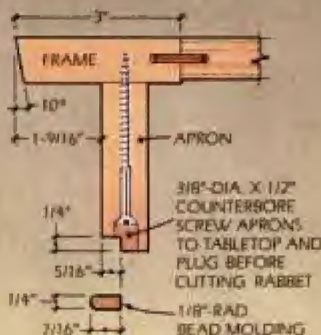
6 Twin flutes cut with a router and $\frac{3}{8}$ -in.-rad. corebox bit are positioned accurately with this guiding jig and spacer.

DINING TABLE

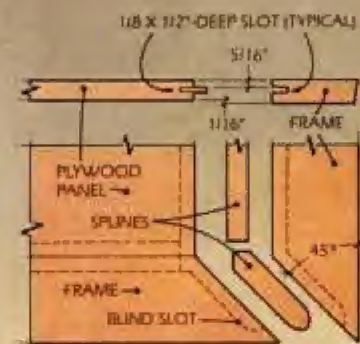
27" HIGH X 36" DEEP X 72" LONG



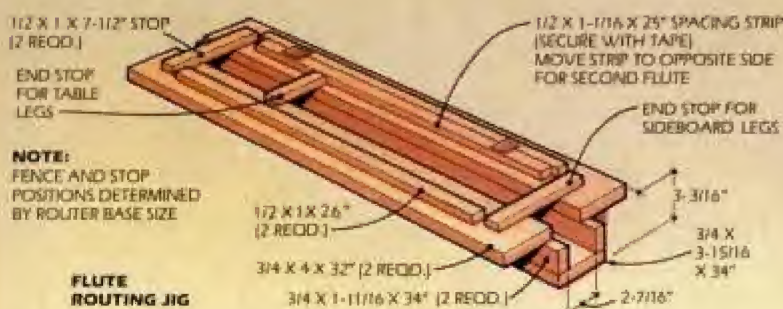
DETAIL 1 - LEG



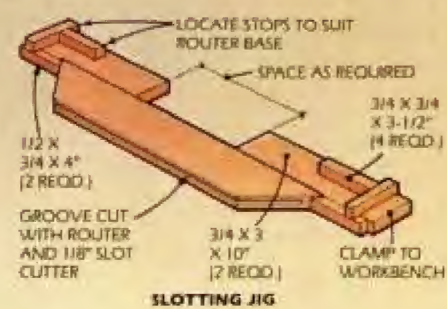
DETAIL 2 - APRON



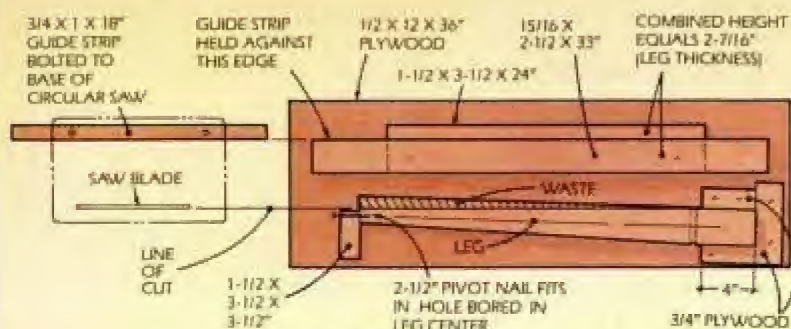
DETAIL 3 - TABLETOP



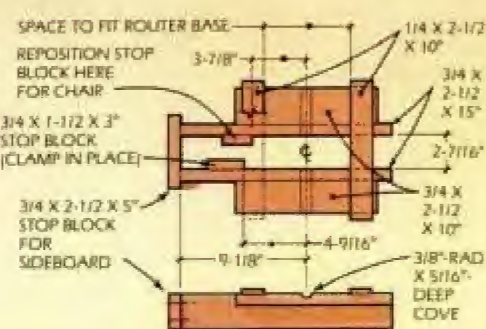
FLUTE ROUTING JIG



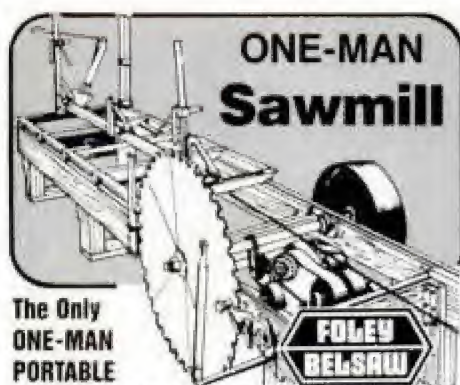
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WOODWORKING GUIDE

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Because the circular saw tends to tear the top surface of the wood, first select the best side of the panel and then flip it over to make the cut.

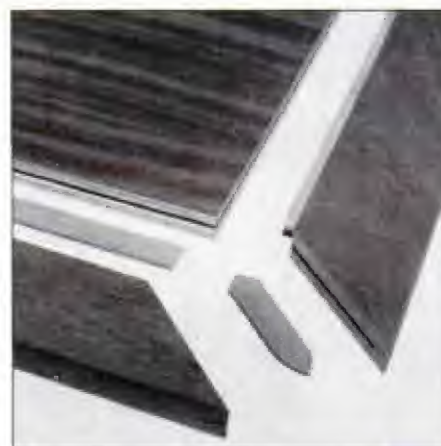
Next, rip the tabletop frame pieces to width and plane the sawn edges smooth. Crosscut them slightly oversize in length and hold each piece up to the plywood panel to mark for the miters. The frame miter joints and the frame-to-panel joints are splined.

Use your router with a slot cutter to make the 1/4-in.-wide grooves. The spline joint at the miters doesn't extend through the corner. So, set up a stopping jig to cut these blind slots as shown in the drawing. When cutting the grooves, keep the base of the router on the top face of the frame pieces and panel for accurate registration.

We used 1/4-in.-thick plywood for the splines but similar size hardboard could be used as well. They shouldn't fit too tightly. When the glue is applied they'll swell, making assembly difficult. If necessary, plane the spline surfaces for a slip fit.



7 Bead trim is made in four steps. After routing two half-rounds, use slotting bit for trim pieces, then cut off with circular saw.



9 Plywood, 1/4 in. thick, is used for the splines. Leave room in groove bottoms for excess glue. Dry assemble to check fits.

Before gluing, dry assemble the top to ensure that all the pieces have been cut properly. First draw the long side pieces against the panel with bar clamps and then position the ends.

If you don't have bar clamps long enough to span the length of the top, use two C-clamps and wedges (photo 10). Clamp the assembly tight and let the glue set overnight. After the glue has dried, plane the 10° bevel around the perimeter as shown in the drawing.

Assembling the frame

Cut enough 3/4-in. dowels 1 1/2 in. long to assemble the entire skirt. Chamfer the ends with a file or sandpaper and groove each pin to allow excess glue to escape. You can also buy pregrooved dowel pins cut to length. Begin the assembly by applying slow-setting hide glue sparingly to the holes and dowel pins for the short end rails and legs. After these leg pairs have set, join them to the two long rails. Make sure the floor your working on is flat. If necessary, place shims under the legs to keep the frame true.

After the glue has dried thoroughly, lay the tabletop upside down and posi-



8 Slotting bit cuts spline grooves in plywood panel and frame. Use a stopping jig for blind grooves in miter joints.



10 C-clamps and wedges bring the end frame pieces into position. After the glue has set, trim a 10° bevel on tabletop edges.

tion the leg and skirt assembly on it. Mark the hole positions for the top fastening screws and lightly mark with pencil the leg corner positions. Then, shift the frame aside to bore the screw pilot holes. Use a drill stop or masking tape wrapped around the bit to act as a depth guide.

Slide the frame back in place, align it with the pencil marks and secure the base to the top with 3-in. No. 10 fh wood screws. To ensure extra rigidity to the tabletop panel, add two interior cross rails. Cut four cross-rail cleats each with a centered $\frac{13}{16}$ -in.-wide \times $\frac{1}{2}$ -in.-deep dado as shown in the drawing. Then, rip the rails to width, crosscut them exactly to length and attach each cleat to a rail end with one 4d nail and glue. Screw the rail assemblies in place with $1\frac{1}{4}$ -in. No. 10 fh screws. Because the plywood panel is $\frac{1}{8}$ in. thinner than the solid frame, you'll have to shim the cross rails on top for proper support. Next, assemble the corner blocks and install them with $\frac{5}{16} \times 3\frac{1}{2}$ -in. lagscrews and glue.

Finishing the job

After the table has been assembled, trim the bead molding to fit the rabbets in the end and side apron pieces. Secure with glue and $\frac{1}{2}$ -in. brads. Let the glue dry and then scrape off squeeze-out with a sharp chisel. Using 120-grit sandpaper, ease the sharp corners on all table parts. Then, sand the entire table with 120-grit, followed by 220-grit sandpaper and prepare for finishing by cleaning the table with a tack cloth.

We used Benjamin Moore Red Mahogany Stain on all three pieces of furniture to give the wood a deep traditional color. Follow the stain with three coats of McCloskey's Satin Polyurethane Varnish thinning the first coat six parts varnish to one part thinner. Between coats, lightly sand with 220-grit sandpaper and clean with a tack cloth. **PM**



11 Corner blocks add rigidity to the frame. Secure to the legs with $\frac{5}{16} \times 3\frac{1}{2}$ -in. lagscrews and to the apron with glue.



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Elegance On The Side

A well-mannered mahogany sideboard will accent your dining room.

BY ROSARIO CAPOTOSTO, Contributing Editor

Look back far enough into the history of dining furniture—somewhere around the time food was served on massive trestle tables and guests sat on long wooden benches—and you'll find the origin of the sideboard. Originally designed as a simple surface to hold food and related accessories, it gradually acquired doors and drawers and became the cabinet we know today.

Sometimes referred to as a buffet, the sideboard is an excellent example of the cabinetmaker's art.

Our mahogany version features the rich detailing found on traditional pieces but requires only standard portable power tools to create. Keep in mind that careful attention to jig construction is the key to successfully completing each piece in the dining set.

Starting out

The $2\frac{7}{16}$ -in.-sq. leg stock is prepared by first gluing together three layers of $\frac{13}{16}$ -in. mahogany. After the glue has dried, rip each leg to width allowing a little extra for dressing with your hand plane, and cut squarely to the specified length. Use the horizontal cove jig described for the dining table (see page 113), but readjust the end stop to suit the sideboard legs. Cut the cove with a $\frac{3}{8}$ -in.-rad. corebox bit $\frac{5}{16}$ in. deep.

Next, cut the leg tapers that begin at the cove and extend to the leg bottom (photo 3). Modify the table leg tapering jig to suit the proportions of the sideboard leg as shown in the drawing. The ledge that your circular saw rides on must be the same height as the leg thickness. Sandwich together a 2x4 base with a full 1-in.-thick top planed to $\frac{15}{16}$ in. to get the required height. Be sure to position the ledge to obtain the correct line of cut as shown in the drawing. After the tapers are cut, dress the sides

smooth with a sharp hand plane.

While the router is still set up with the corebox bit, cut the twin vertical flutes on two sides of each leg. Again, you can use the jig described for the dining table (see page 113). Remove the end stop for the table legs and use an appropriately placed stop for the longer flutes. When cutting the flutes, keep in mind that the cabinet front will have a more uniform appearance if you orient the glue lines on the legs toward the case side.

Now, replace the corebox bit with a $\frac{1}{4}$ -in.-dia. straight bit and attach an edge guide to the router base for cutting the $\frac{1}{4}$ -in.-deep stopped grooves that house the side panels. Stop these grooves $2\frac{1}{4}$ in. from the leg top and $13\frac{1}{4}$ in. from the bottom. Then, square the rounded ends with a sharp $\frac{1}{4}$ -in. chisel.

Making the framework

Prepare the rails for the cabinet sides, front and back by ripping to width, dressing the sawn edges and crosscutting to exact length. Then, use a doweling jig to aid in boring the $\frac{3}{8}$ -in.-dia. dowel holes in the rail ends. Insert dowel centers in the side rails and transfer the locations to the legs. The lower edge



This handsome mahogany sideboard makes the case for quality construction, sensitive attention to detail and exceptional utility. Richly finished in a deep mahogany stain, this piece is sure to win the approval of your family, friends and dinner guests. And, as the maker, you'll have the ultimate satisfaction of knowing you made it in your own workshop with ordinary portable power tools.

Sideboard design: Thomas Klenck, Associate Editor
Black-and-white photos: Rosario Capotosto
Technical art: Eugene Thompson
Color photo: J.R. Rost
Photo stylist: Gabe Hemick



of the bottom rail is placed 11 in. from the leg bottom and the upper rail is flush with the leg top.

As with both the table and chair, the sideboard rails feature a $\frac{1}{8}$ -in. bead trim. You can cut two lengths of trim from each edge of $\frac{1}{8}$ -in. stock by using a $\frac{1}{8}$ -in.-rad. half-round bit and slotting bit as described for the dining table (see photo 7 on page 114). The router with straight bit and edge guide is used to cut the rabbet that receives the trim. Note that it only appears on one edge of the front and top side rail, and on both of the

edges of the bottom side rail.

Also, the inner side rail rabbets must be cut wider to accommodate the $\frac{1}{8}$ -in.-thick plywood panel that fits behind the bead trim. Cut the panels to size and prepare to assemble the end units by finish sanding the panel, rails and legs. Then, apply glue and use bar clamps to bring the parts together.

While the ends are drying, you can start on the interior frames. Both frames require identically cut components. Cut each piece to size and assemble with glue and dowels as shown in the

drawing. Before assembling, however, bore the dowel holes in the ends of the long frame members for joining to the legs. Be sure to dress the front edges of the frames because these surfaces remain exposed in the finished piece. After constructing the frames, cut the plywood floor panel to size and notch the corners with a sabre saw as shown in the drawing.

Next, cut the side cleats to size and attach them to the floor and frame ends with glue and 4d nails. Bore dowel holes in the long edges of the floor panel for

ELEGANCE

joining the front and rear rails and transfer their locations to the rails. Then, set the front rail aside and glue the rear rail only to the panel.

Set up a guide and rout the $\frac{1}{4}$ -in.-deep $\times \frac{3}{4}$ -in.-wide dados across the rear rail and floor panel. Without changing the router setup, move to the frames and rout the grooves for the center support that stop $\frac{13}{16}$ in. short of the frame front edge. Then, flip the lower frame over and cut similar grooves for the plywood partitions. Use a sharp chisel to square the groove ends.

With the grooves completed, glue the front rail to the floor panel and bore and countersink screw holes in the upper frame for fastening the sideboard top. Next, cut the drawer guides notching the end ones as shown in the drawing. Secure the end drawer guides with 4d finish nails and glue leaving the inner guides for later installation.

The three partitions and center support are made of $\frac{3}{4}$ -in.-thick lauan plywood. After cutting these panels to size, make up $\frac{1}{4}$ -in.-thick mahogany edge

banding and glue in place. It's best to make the banding slightly wider than the $\frac{3}{4}$ -in. panel. After the glue has set, use a sharp, finely set plane to trim the banding flush.

Assembling the case

With the case ends, frames and floor assembled, proceed to mark the corresponding dowel hole positions in the legs. First, prepare a number of dowels for dry assembly by sanding them for a slip fit. Working upside down on a flat surface, insert dowel centers in the top frame and mark the corresponding positions on the legs. Bore the holes in the legs for joining the top frame. Insert the slip-fit dowels in the frame ends and temporarily place a few 5-in.-wide spacers on top. Lay the second frame on the spacers and insert dowel centers in the ends. Carefully bring the leg assemblies into position on the slip-fit dowels and mark the hole locations for joining the second frame.

To mark the locations for the floor assembly, insert the partitions in their housings in the lower frame, position the floor on top with centers installed

and repeat the above process.

After all dowel holes have been bored, make a dry assembly to ensure that all parts fit properly. Because gluing up the cabinet will require some time, use slow-setting hide glue. Begin by gluing and nailing the floor assembly to the partitions with 6d finish nails. Flip this over and join the lower frame in the same way. Then, nail and glue the two inner drawer guides in place. Lay the case on its back and attach the center support with glue to the lower frame followed by nailing and gluing the top frame to the support. Apply glue to the dowels and holes for joining the side units to the frames and floor. Then spread glue on the upper and lower side cleat faces. Slide the end units in place and clamp until dry. If you don't have clamps long enough to span 72 in., you can use an arrangement of smaller clamps. Use a small C-clamp to hold blocks to the long rails. Then tighten larger clamps against them to draw in the case sides (photo 11).

The sideboard top is constructed in the same manner as the dining table top. Cut the panel to size, fit the mitered



1 Glue up the leg stock and use a circular saw guided by a straightedge to rip. Scrap panel underneath protects the bench.



2 After cutting the horizontal coves, bolt a fence to the saw base and set up the tapering jig to shape the leg bottoms.



3 Circular saw rides on a $2\frac{7}{8}$ -in. ledge spaced at the appropriate line of cut. Rotate the stock after each pass.



4 Use a sharp, finely set smoothing plane to dress the rough sawn surfaces of each of the legs before routing the flutes.



5 The flute routing jig guides router when making stopped flutes. Use a $\frac{3}{8}$ -in.-rad. corebox bit set for $\frac{5}{16}$ -in.-deep cuts.



6 Tape spacer to side rail to provide support on both sides of the router. Shift spacer to the other side for second flute.

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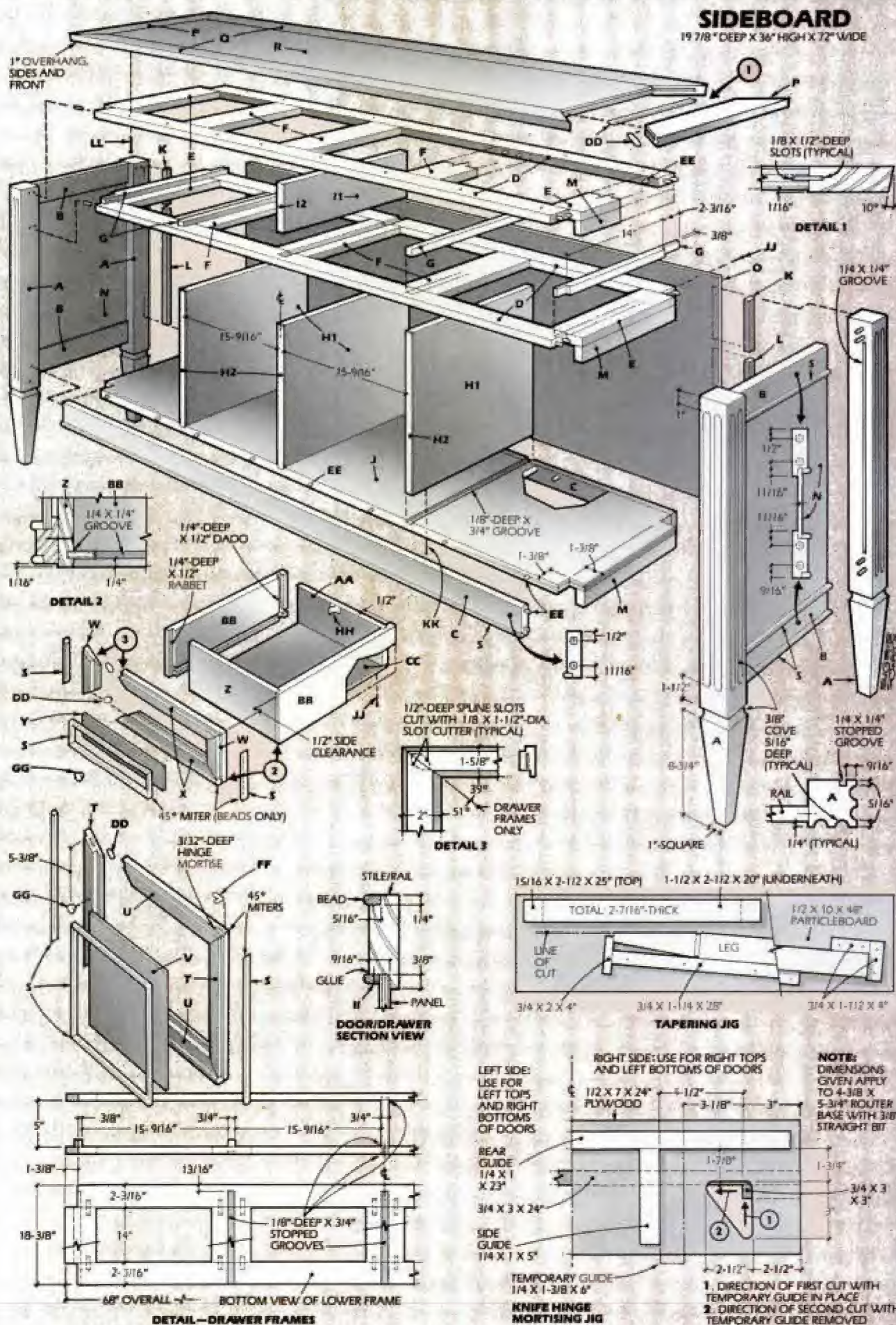
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SIDEBOARD

19 7/8" DEEP X 36" HIGH X 72" WIDE



MATERIALS LIST—SIDEBOARD

Key	No.	Size and description (use)
A	4	$2\frac{3}{16}$ x $2\frac{1}{16}$ x $35\frac{3}{16}$ " mahogany (leg)
B	4	$\frac{1}{16}$ x $2\frac{1}{2}$ x 14" mahogany (side rail)
C	2	$\frac{1}{16}$ x $2\frac{1}{2}$ x $65\frac{1}{16}$ " mahogany (front/back rail)
D	4	$\frac{1}{16}$ x $2\frac{1}{16}$ x $65\frac{1}{16}$ " mahogany (long frame)
E	4	$\frac{1}{16}$ x $3\frac{1}{4}$ x 14" mahogany (end frame)
F	6	$\frac{1}{16}$ x 4 x 14" mahogany (inner frame)
G	4	$\frac{1}{4}$ x $\frac{1}{16}$ x $17\frac{1}{16}$ " mahogany (drawer guide)
H1	3	$\frac{1}{4}$ x $15\frac{1}{16}$ x $17\frac{1}{16}$ " lauan plywood (partition)
H2	3	$\frac{1}{4}$ x $\frac{1}{4}$ x $15\frac{1}{16}$ " mahogany (edge band)
I1	1	$\frac{1}{4}$ x $5\frac{1}{4}$ x $17\frac{1}{16}$ " lauan plywood (support)
I2	1	$\frac{1}{4}$ x $\frac{1}{4}$ x $5\frac{1}{4}$ " mahogany (edge band)
J	1	$\frac{1}{4}$ x $16\frac{1}{4}$ x 68" lauan plywood (floor)
K	2	$\frac{1}{4}$ x $\frac{1}{16}$ x 5" mahogany (back cleat)
L	2	$\frac{1}{4}$ x $\frac{1}{16}$ x $15\frac{1}{16}$ " mahogany (back cleat)
M	6	$\frac{1}{16}$ x $1\frac{1}{2}$ x 14" mahogany (side cleat)
N	2	$\frac{1}{4}$ x $14\frac{1}{4}$ x $19\frac{1}{16}$ " mahogany plywood (side panel)
O	1	$\frac{1}{4}$ x $24\frac{1}{16}$ x $65\frac{1}{16}$ " lauan plywood (back)
P	2	$\frac{1}{16}$ x 3 x $19\frac{1}{16}$ " mahogany (top short frame)
Q	2	$\frac{1}{16}$ x 3 x 72" mahogany (top long frame)
R	1	$\frac{1}{4}$ x $13\frac{1}{4}$ x 66" mahogany plywood (top panel)
S*		$\frac{1}{4}$ x $\frac{1}{16}$ " mahogany (bead trim)
T**	8	$\frac{1}{16}$ x 2 x $15\frac{1}{16}$ " mahogany (side door frame)
U**	8	$\frac{1}{16}$ x 2 x $16\frac{1}{16}$ " mahogany (top/bottom door frame)
V	4	$\frac{1}{4}$ x $11\frac{1}{16}$ x $13\frac{1}{16}$ " mahogany plywood (door panel)
W**	8	$\frac{1}{16}$ x 2 x 5" mahogany (side drawer frame)
X**	8	$\frac{1}{16}$ x $1\frac{1}{4}$ x $16\frac{1}{16}$ " mahogany (top/bottom drawer frame)

Y	4	$\frac{1}{4}$ x $2\frac{1}{2}$ x $13\frac{1}{16}$ " mahogany plywood (drawer panel)
Z	4	$\frac{1}{2}$ x $4\frac{1}{16}$ x 15" poplar (drawer front)
AA	4	$\frac{1}{2}$ x $4\frac{1}{16}$ x 15" poplar (drawer back)
BB	8	$\frac{1}{2}$ x $4\frac{1}{16}$ x $17\frac{1}{16}$ " poplar (drawer side)
CC	4	$\frac{1}{4}$ x $14\frac{1}{2}$ x $16\frac{1}{16}$ " poplar plywood (drawer bottom)
DD		$\frac{1}{4}$ x $\frac{3}{8}$ " plywood (spline)
EE		$\frac{3}{16}$ -dia. x $1\frac{1}{2}$ " hardwood dowel
FF*	4	fast pin knife hinge
GG*	8	1"-dia. polished brass Sheraton pull
HH†	4	drawer stop
II		$\frac{1}{8}$ " wire braid
JJ		4d finish nail
KK		8d finish nail
LL	16	$1\frac{1}{4}$ " No. 10 fh screw

Misc: 120- and 220-grit sandpaper, glue, Benjamin Moore Red Mahogany Stain, McCloskey's Satin Polyurethane Varnish.

* Approximately 80 linear ft. required.

** Tight fit—trim to proper clearance.

† Door and drawer pulls (No. 566) available from Paxton Hardware, 7818 Bradshaw Rd., Upper Falls, MD 21156 (\$1.95 each). Knife hinge (No. 78004, four pairs \$8.50) and drawer stop (No. 78015, set of four \$7.50) available from Armor Products, Box 445, East Northport, NY 11731.

frame and glue the assembly together with $\frac{1}{8}$ -in.-thick plywood splines. Then, fasten it to the top frame with $1\frac{1}{4}$ -in. No. 10 fh screws. Cut the $\frac{1}{4}$ -in.-thick back panel to size and install the back mounting cleats to the rear legs with 4d nails and glue.

Doors and drawers

Both the doors and drawers feature mitered frame and panel construction. The drawer frame-and-panels are actually false fronts that are eventually fastened to the drawer box front with 1-in. No. 10 fh screws. Cut all frame pieces to width and slightly oversize in length. Then, trim the miters to exact length. Note that the drawer frame top and bottom pieces are cut at 39° and the sides are cut at 51° . This allows the top and bottom pieces to be slightly narrower than the sides, creating a better proportioned panel. Before cutting the miters, rout the $\frac{3}{8}$ x $\frac{9}{16}$ -in. rabbet—that houses the panel and bead trim—on one edge of each piece. Set up a guiding jig to cut the miters and use tape to hold the small pieces in place for cutting.

Although it's possible to cut the blind slots for the frame spline joints with a handheld router, it's more convenient to use a router table. If you don't have one, you can mount your router upside down in a scrap plywood panel so the bit passes through a hole. The pilot on the slotting bit will ensure accurate cutting depth. Set up guides on the router table



7 After marking the side rail hole positions in the legs, use a dowelling jig to cut $\frac{1}{8}$ -in.-dia. x $1\frac{1}{16}$ -in.-deep holes.



8 Clamp stops in place. Use an edge guide to rout the $\frac{1}{4}$ -in.-wide grooves in the legs that house the side panels.



9 The frames require $\frac{3}{4}$ -in.-wide grooves to house the partitions and center support. Stop these $1\frac{1}{16}$ in. from the outside edge.



10 Mark the hole centers first for the top frame, then lower frame and finally the floor. Use spacers to support the units.



11 If you don't have long bar clamps, you can clamp blocks to the frames for clamping the sides. Slow-setting hide glue is best.



12 Cut joint slots with slotting bit. Guides keep the slot from going through corners. Tape short sections for safer operation.

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to keep from cutting through the entire miter joint. Use a coping saw to cut the $\frac{1}{4}$ -in.-thick plywood splines (photo 13) and apply glue sparingly.

While a band clamp or frame clamp could be used to hold the parts together, we used strips of masking tape on both sides of the joint. When all the frames are complete, lay the cabinet on its back, place each frame in position and plane the edges to achieve the correct clearance between parts. Leave $\frac{1}{16}$ in. between the door and drawer sides and the case, and $\frac{1}{8}$ in. between the doors and drawers. When you're satisfied with the fit, rout the $\frac{1}{4} \times \frac{1}{16}$ -in. rabbet around the perimeter of each frame that accepts the bead trim. Then, miter each piece of perimeter trim to fit and install them with glue and brads.

Because the trim is so small, the bead miters are best cut with a dovetail saw and mitering jig. To build this jig, first sandwich together two pieces of $\frac{13}{16} \times 2$ -in. stock around a $\frac{1}{4} \times 1$ -in. strip. Then, set your circular saw to 45° and crosscut both ends (photo 15). You can

make several of these jigs at the appropriate lengths to cut each mitered bead without repeated measuring.

Cut all the drawer box parts to exact size. Rout the $\frac{1}{2}$ -in.-wide dado and rabbet in each drawer side followed by a $\frac{1}{4} \times \frac{1}{4}$ -in. groove in the sides and front to hold the drawer bottom. Glue and nail the sides to the front of each drawer, slide in the bottoms and install the back panel with 2d finish nails.

The door knife hinges require $\frac{3}{32}$ -in.-deep mortises in the door frames. Construct the knife hinge mortising jig as shown in the drawing. Only half of this symmetrical jig is shown. One side will cut all the mortises in the upper right and lower left frame corners, and the other side guides the cuts for the remaining hinges (photo 14). You'll need to adjust the jig guides to suit the size of your router. Use a $\frac{3}{8}$ -in.-dia. straight-bit to cut the L-shaped mortises so the short leg of the hinge is flush with the door side and the long leg is $\frac{3}{16}$ in. from the back.

Next, cut the door and drawer panels to size and carefully miter the bead trim that surrounds each panel. Glue the



13 Cut $\frac{1}{4}$ -in.-thick plywood splines shaped to fit the slots. Use a yellow glue and tape the joints until the glue sets.



15 A fine dovetail saw cuts bead miters for door and drawer frames. Construct mitering jigs to suit the lengths of trim.



14 Hinge mortising jig guides router when making $\frac{3}{16}$ -in.-deep mortises in the doors. Space guides to suit your router.

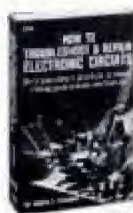


16 After gluing panels, glue and nail trim in place. Short sticks provide clamping pressure where beads can't be nailed.



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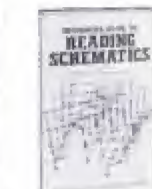
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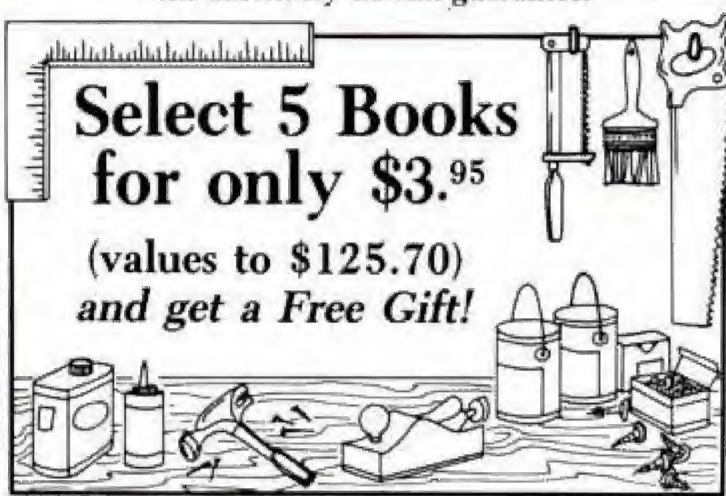
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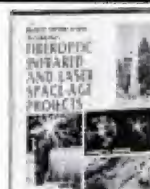
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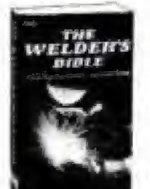
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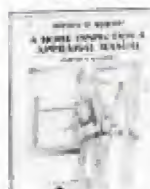
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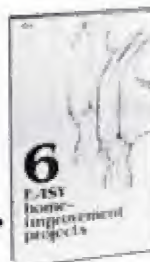
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panels in place and install the trim with 1/2-in. brads and glue.

To position the drawer frames on the drawers, first drive four 3d finish nails through each drawer front so the points just poke through. Then, slide each drawer into the cabinet and press the drawer frames in place to transfer locating marks to the frames. Remove the drawers and screw the front frames permanently to the drawers as aligned by the nail points. Then, remove the nails.

To mark the corresponding hinge screw hole positions in the cabinet, make a template out of a 1 1/4 x 2-in. piece of sheetmetal. Bend this over a piece of 1 3/16-in. stock so one long edge is flush with the board face. Then transfer the hole centers from a hinge. Keep the long leg of the hinge 3/16-in. in from the edge and the short leg flush with the end. Bore small holes at the marks. Place this template at the appropriate door edge positions and use an awl to mark the hole centers. Then, attach one hinge to the door bottom and its mate to the frame at the top so you'll only need to screw in a downward direction to complete the installation.

Apply a coat of sanding sealer to all interior surfaces of the cabinet before attaching the back panel. Then, glue and nail it in place. Final finishing begins by sanding with 120- then, 220-grit sandpaper. Allow the dust to settle before cleaning with a tack cloth. The sideboard is stained and varnished with Benjamin Moore Red Mahogany Stain and three coats of McCloskey's Satin Polyurethane Varnish.

After the last coat has dried, carefully mark the hole locations for the door and drawer pulls. Bore these with an appropriately sized bit and install the pulls. Then, remove each drawer and install the drawer catches to the upper inside edges of the drawer backs. **PM**



17 Hinge screw hole template ensures accurate positioning of doors. Use an awl to mark for the screw pilot holes.

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Sit down to dinner on this beautiful dining chair you can make yourself.

BY ROSARIO CAPOTOSTO, Contributing Editor

Of all the areas of woodworking, chairmaking stands out as a specialized field. Here, the skills of the joiner are paramount because chairs are subject to stresses not normally found in other pieces of furniture.

It's not enough, however, to simply make a strong chair. It must be light enough to be carried easily and shaped to accommodate a wide range of users. In addition, the chair design must complement its surroundings without sacrificing utility.

As with its partners in the dining room suite, our mahogany chair is constructed of $\frac{1}{2}$ -in. stock and it's designed to be made with the portable power tools found in most home workshops. Making six chairs may seem like an overwhelming task but, by using our jigs and grouping similar operations together, you'll find it's not much more difficult than making just one.

Shaping the legs

Our modified cabriole leg was designed to echo the tapers found in the companion pieces. Begin the front legs by preparing the leg stock and routing the horizontal cove (as described for the dining table on page 113).

Use the same cove jig you used on the table legs but readjust the end stop appropriately for the chair.

The inside radius found on the bottom of each leg is shaped by boring precisely placed $1\frac{1}{2}$ -in.-dia. holes.

Construct the leg hole boring jig as shown in the drawing. Using a drill guide to ensure that the holes are square to the leg face, bore two holes at right angles to each other with a $1\frac{1}{2}$ -in.-dia. Forstner bit (photo 1). The spacing

of the stop that positions the drill guide is based on the *Portalign drill guide* we used. If you're using a different guide, readjust the stop accordingly.

Cut the straight tapers—that begin at the horizontal cove and are tangent to the $1\frac{1}{2}$ -in. holes—most of the way with a circular saw. Use the front leg tapering jig to guide the saw and set the length-of-cut stop to end the cut just before the $1\frac{1}{2}$ -in.-dia. hole.

Finish the cuts with a sabre saw. Then mark the outside curves on the bottom of the leg and use your sabre saw to complete the profile.

The inside radius of each leg can be smoothed with an appropriately sized drum sander mounted in an electric drill, or by hand with sandpaper wrapped around a large dowel. Use a block and sandpaper to clean up the outside foot surfaces and a pad sander on the flat tapered sides.



The chairback

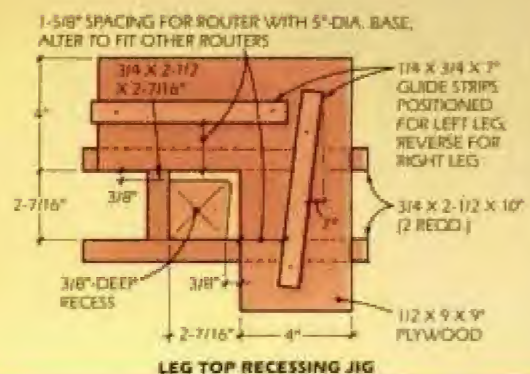
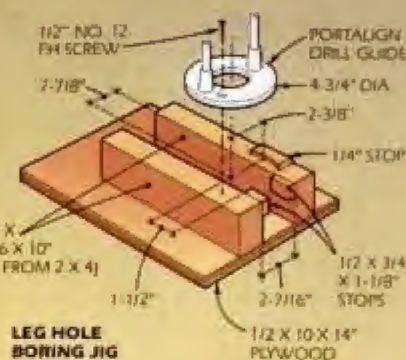
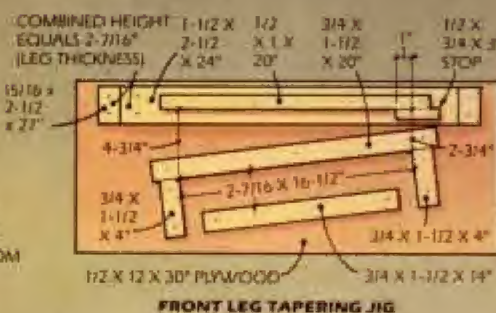
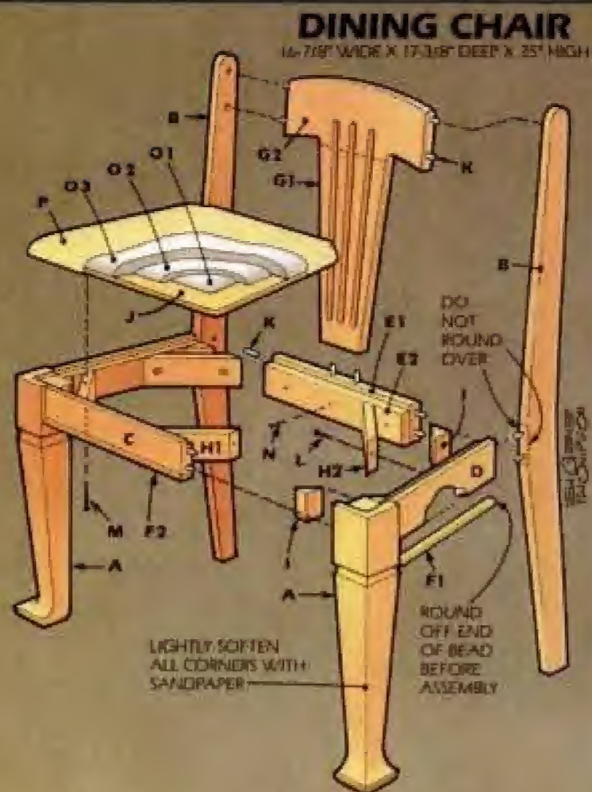
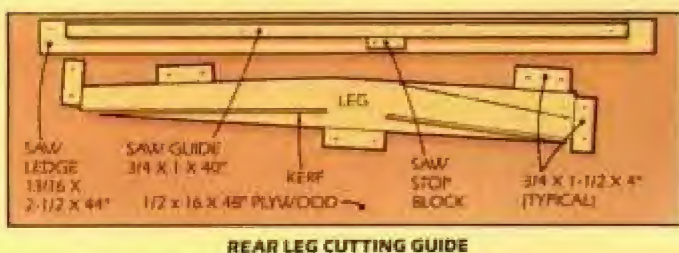
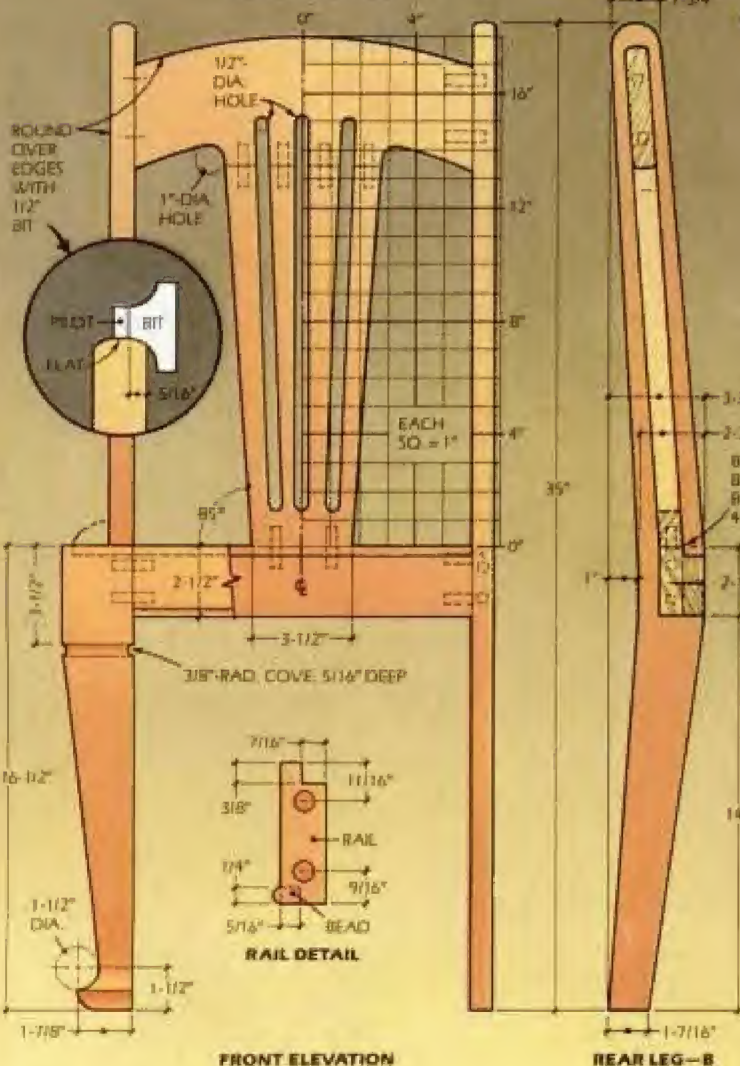
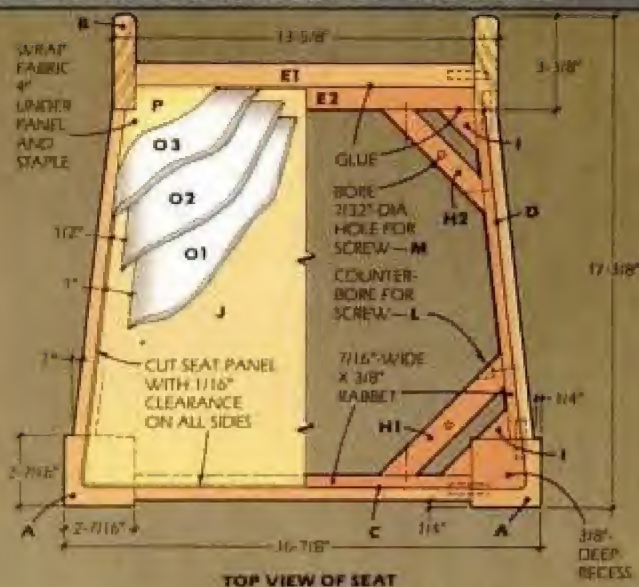
Cut the boards for the chairback upper sections about 1 in. oversize in width and exactly to length. The lower back section is cut 1 in. longer and wider than specified. Bore $\frac{3}{8}$ -in.-dia. holes for the dowels that join the two sections as shown in the drawing. Be sure to place the holes so the slots that must be cut later won't interfere with the joint. Apply glue sparingly to the holes and dowels, clamp up and let dry overnight. After the clamps are removed, trim the bottom of the lower back section to length at a 4° bevel.

Next, make a cardboard template of the complete back outline and transfer the shape to each blank. Before cutting, however, bore 1-in.-dia. holes at the inside corners and $\frac{1}{2}$ -in.-dia. holes at the ends of the slots. Then, use your sabre saw to cut close to, but not on, the lines. To make the backs completely uniform and minimize sanding, carefully cut a plywood template to guide your router and $\frac{1}{4}$ -in. straight bit around the slots and top section outline. You'll need a template guide mounted on the router base for following the template. Measure the distance from the bit cutting edge to the guide and offset the template outline this amount. After trimming, clean up the outside edges of the lower section as close to the inside corner as possible with a hand plane. Finish up with sandpaper and block.

Cut the stock for the rear legs to $3\frac{1}{2}$ -in.-wide \times 35-in.-long and construct the rear leg cutting guide as shown in the drawing. By positioning the stock holding blocks and saw stop appropriately you can make all four long cuts with your circular saw. The block positions shown in the drawing hold the stock for the lower rear cut. If the grain of the leg stock is not entirely straight, orient it so it conforms to the final shape of the legs. Make the same cut on each piece before repositioning the blocks and stop. The back of the rear leg is finished by connecting the circular saw cuts with a straight cut made with your sabre saw. Complete the leg profile by rounding

We've streamlined the construction techniques of this tastefully appointed chair to make it accessible to any woodworker equipped with portable power tools.

Chair design: Thomas Klencik, Associate Editor
Black-and-white photos: Rosario Capotosto
Technical art: Eugene Thompson
Color photo: J.R. Kost
Photo stylist: Gabe Henrick



MATERIALS LIST—DINING CHAIR

Key	No.	Size and description (use)
A	2	$2\frac{1}{16}$ x $2\frac{1}{16}$ x $16\frac{1}{2}$ " mahogany (front leg)
B	2	$1\frac{1}{16}$ x $3\frac{1}{2}$ x $35\frac{1}{2}$ " mahogany (rear leg)
C	1	$1\frac{1}{16}$ x $2\frac{1}{2}$ x $12\frac{1}{2}$ " mahogany (front rail)
D*	2	$1\frac{1}{16}$ x $2\frac{1}{2}$ x $12\frac{1}{2}$ " mahogany (side rail)
E1	1	$1\frac{1}{16}$ x $2\frac{1}{2}$ x $12\frac{1}{2}$ " mahogany (back rail)
E2	1	$1\frac{1}{16}$ x $2\frac{1}{2}$ x $12\frac{1}{2}$ " mahogany (cleat)
F1*	2	$\frac{1}{4}$ x $\frac{7}{16}$ x $12\frac{1}{2}$ " mahogany (side bead)
F2	1	$\frac{1}{4}$ x $\frac{7}{16}$ x $12\frac{1}{2}$ " mahogany (front bead)
G1	1	$\frac{1}{16}$ x $5\frac{1}{2}$ x $13\frac{1}{16}$ " mahogany (lower seatback)
G2	1	$\frac{1}{16}$ x $4\frac{1}{2}$ x $12\frac{1}{2}$ " mahogany (upper seatback)
H*	4	$1\frac{1}{16}$ x $2\frac{1}{2}$ x $5\frac{1}{2}$ " mahogany (corner brace)
I*	6	$1\frac{1}{16}$ x $2\frac{1}{2}$ x $2\frac{1}{2}$ " mahogany (corner block)
J*	1	$\frac{5}{8}$ x 14 x $16\frac{1}{2}$ " fir plywood (seat)
K	26	$\frac{3}{16}$ "-dia. x $1\frac{1}{2}$ " hardwood dowel
L	8	1" No. 10 fh screw
M	4	$2\frac{1}{2}$ " No. 10 fh screw
N	3	6d common nail
O1	1	$\frac{1}{2}$ x 12 x $14\frac{1}{2}$ " foam (bottom layer)
O2	1	$\frac{1}{2}$ x 13 x $15\frac{1}{2}$ " foam (middle layer)
O3	1	$\frac{1}{2}$ x 14 x $16\frac{1}{2}$ " foam (top layer)
P**	1	23 x $25\frac{1}{2}$ " fabric

Misc: 120- and 220-grit sandpaper, glue, $\frac{1}{4}$ -in. staples and staple gun, Portalign drill guide (\$25), and $1\frac{1}{2}$ -in.-dia. Forstner bit (\$25) available from Constantine's, 2050 Eastchester Rd., Bronx, NY 10461.

* Cut to fit.

** Fabric (style: Cardine, color: Parchment, \$24 per yard, approx. 3 yards required) available from A & N Fabrics, 208 W. 30 St., New York, NY 10018.

CHAIRMANSHIP

the leg top with the sabre saw and dress the edges smooth with a hand plane and sandpaper.

Our design calls for a rounding of the edges of the rear legs and back that softens the form but still leaves a corner to define the shape. Make this cut with a $\frac{1}{2}$ -in.-rad. bit mounted in the router. Adjust the bit depth so the cutting edge protrudes only $\frac{5}{16}$ in. beyond the base. Then, rout both sides of each leg and back. Although we performed this operation on a router table, it can easily be done with a handheld router. Before routing the rear legs, however, temporarily attach a strip of wood $2\frac{1}{2}$ in. long to the area where the side rails join. This prevents rounding over and ruining the mating surface.

Making the joints

First, rip the stock for the chair rails and rear-seat support cleat to width and cut the front and rear pieces to exact length. Before crosscutting the side rails, reset your circular saw to cut a 7° bevel and crosscut the stock so it's $11\frac{25}{32}$ in. long as measured on one face.

Keep in mind that these beveled cuts must be parallel making the overall length slightly greater than $11\frac{25}{32}$ in.

Rout the $\frac{1}{4}$ x $\frac{5}{16}$ -in. rabbet for the bead trim on one edge of the front and side rails. Be sure to place this rabbet on the lower outside corner of the side rails. Then use a doweling jig to bore the dowel holes in the front and rear rail. Because the side rails are beveled, make two 7° wedges to position the doweling jig square to the ends (photo 6). Use the same technique with 4° wedges for the holes in the lower section of the chairback. Prepare to transfer the hole locations to the front legs by first laying out a full-size outline of the frame and then nailing stops in place to position the pieces. Next, use dowel centers to mark the front leg hole positions and use a similar system for marking the rear leg joints. After all dowel holes are bored, nail and glue the rear rail cleat in place.

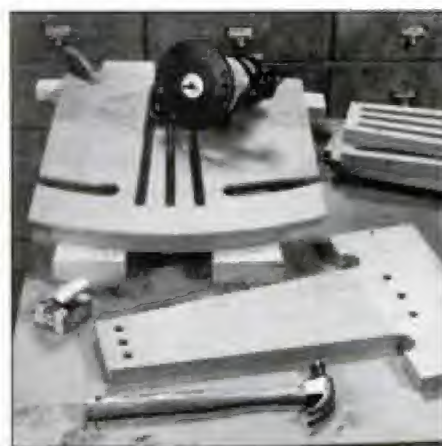
Next, rout the seat recess in the top of each front leg with a $\frac{3}{8}$ -in.-dia. straight bit. Use the jig shown in the drawing for the left legs and simply reverse the stops to recess the right legs. While your router is set up for a $\frac{3}{8}$ -in.-deep cut, rout the $\frac{7}{16}$ -in.-wide rabbets on the



1 Two $1\frac{1}{2}$ -in. holes create the inside curve on the front legs. Use a jig and drill guide for accurate positioning.



2 Start the tapers with a circular saw guided by the tapering jig. Use a sabre saw to finish the cut and round the leg bottom.



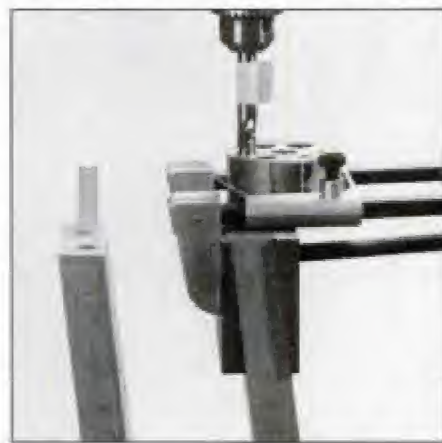
3 Rough cut the backs to shape and bore holes at the slot ends and inside corners. Use a template to rout the finished profile.



4 Rear leg cuts are guided with this jig. The stop keeps the circular saw from cutting too far. Finish with sabre saw.

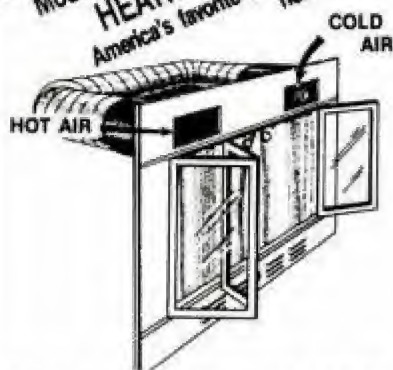


5 Use a partially extended $\frac{1}{2}$ -in.-rad. rounding-over bit to round edges while leaving a corner on the rear legs and back.



6 A dowel jig aids in positioning the $\frac{3}{8}$ -in.-dia. holes. Use two 7° wedges to ensure the holes are square to the side rail ends.

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CHAIRMANSHIP

top inside edge of the side and front rails. Finally, using a $\frac{1}{8}$ -in.-rad. half-round bit and a slotting bit, make up the bead trim. (See explanation on page 112.) Install the beading in the front and side rail lower rabbets as shown in the drawing. Use glue and brads to attach the molding and round the back end of the side rail bead where it terminates at the rear leg.

Assembling the chair

Begin by gluing together each front and rear leg with one side rail. Because this assembly is not flat and square, it's easier (and faster, too) to clamp these side units in pairs. Set each pair upside down on the edge of your worktable and use a single bar clamp and two boards to hold the parts together. While these are setting, glue the chair back to the rear rail.

When both assemblies are dry, join the side units to the chairback and front rail. You should need only three bar clamps per chair for this operation. Before fully tightening the clamps, place the chair upright on a flat surface to en-

sure that the frame's not twisted. Then, tighten the clamps and let the glue dry overnight. Remember, excess glue that's squeezed out of the joints can ruin the staining and varnishing job. Apply glue sparingly to the holes and dowels and remove any excess after it's dry using a sharp chisel and sanding carefully with fine paper.

Because of the enormous strains placed on chair frames, we added corner blocks and diagonal braces at each corner. Each chair requires three slightly different corner blocks and two different braces. Take the angles of each corner block and brace from an assembled chair and cut all similar pieces together to save time. After cutting the braces, bore and countersink the screw holes for fastening to the frame and the single hole for the seat-fastening screw. Then, hold them in position and mark the pilot holes in the frames. Prepare to attach the corner blocks by applying glue to the mating surfaces and letting the glue get slightly tacky. Then, press each block in place. Use glue along with the screws when securing the braces. Before installing the seat, finish sand the chair



7 Nail down stops to accurately position components when transferring dowel locations. Use the dowel centers to mark holes.



8 The front leg tops are recessed to receive the seat. After cutting all the right legs, reverse the stops for the left.



9 Gluing the chair sides in pairs balances the clamping load. Assemble the backs and back rails while these dry.



10 Apply slow-setting hide glue sparingly to the dowels and holes for sufficient time to get all the parts together.

The Royal Road To Riches

Dear Friend,

My name is John Wright. Not too long ago I was flat broke. I was \$31,000 in debt. The bank repossessed my car because I couldn't keep up with the payments. And one day the landlord gave me an eviction notice because I hadn't paid the rent for three months. So we had to move out. My family and I stayed at my cousin's place for the rest of that month before I could manage to get another apartment. That was very embarrassing.

Things have changed now. I own four homes in Southern California. The one I'm living in now in Beverly Hills is worth more than one million dollars. I own several cars, among them a brand new Mercedes and a brand new Cadillac. Right now, I have a \$1 million dollar line of credit with the banks and have certificates of deposit at \$100,000 each in my bank in Beverly Hills.

Best of all, I have time to have fun. To be me. To do what I want. I work about 4 hours a day, the rest of the day, I do things that please me. Some days I go swimming and sailing — shopping. Other days, I play racquetball or tennis. Sometimes, frankly, I just lie out under the sun with a good book. I love to take long vacations. I just got back from a two week vacation from — Maui, Hawaii.

I'm not really trying to impress you with my wealth. All I'm trying to do here is to prove to you that if it wasn't because of that money secret I was lucky enough to find that day, I still would have been poor or may be even bankrupt. It was only through this amazing money secret that I could pull myself out of debt and become wealthy. Who knows what would have happened to my family and me.

Knowing about this secret changed my life completely. It brought me wealth, happiness, and most important of all — peace of mind. This secret will change your life, too! It will give you everything you need and will solve all your money problems. Of course you don't have to take my word for it. You can try it for yourself. To see that you try this secret, I'm willing to give you \$20.00 in cash. (I'm giving my address at the bottom of this page.) I figure, if I spend \$20.00, I get your attention. And you will prove it to yourself this amazing money secret will work for you, too!

Why, you may ask, am I willing to share this secret with you? To make money? Hardly. First, I already have all the money and possessions I'll ever need. Second, my secret does not involve any sort of competition whatsoever. Third, nothing is more satisfying to me than sharing my secret only with those who realize a golden opportunity and get on it quickly.

This secret is incredibly simple. Anyone can use it. You can get started with practically no money at all and the risk is almost zero. You don't need special training or even a high school education. It doesn't matter how young or old you are and it will work for you at home or even while you are on vacation.

Let me tell you more about this fascinating money making secret:

With this secret the money can roll in fast. In some cases you may be able to cash in literally overnight. If you can follow simple instructions you can get started in a single afternoon and it is possible to have spendable money in your hands the very next morning. In fact, this just might be the fastest *legal* way to make money that has ever been invented!

This is a very safe way to get extra cash. It is practically risk free. It is not a dangerous gamble. Everything you do has already been tested and you can get started for less money than most people spend for a night on the town.

One of the nicest things about this whole idea is that you can do it at home in your spare time. You don't need equipment or an office. It doesn't matter where you live either. You can use this secret to make money if you live in a big city or on a farm or anywhere in between. A husband and wife team from New York used my secret, worked at home in their spare time, and made \$45,000 in one year.

This secret is simple. It would be hard to make a mistake if you tried. You don't need a college degree or even a high school education. All you need is a little common sense and the ability to follow simple, easy, step-by-step instructions. I personally know a man from New England who used this secret and made \$2 million in just 3 years.

You can use this secret to make money no matter how old or how young you may be. There is no physical labor involved and everything is so easy it can be done whether you're a teenager or 90 years old. I know one woman who is over 65 and is making all the money she needs with this secret.

Here's what newspapers and magazines are saying about this incredible secret:

The Washington Times:

The Royal Road to Riches is paved with golden tips.

Los Angeles Herald Examiner:

We've all got to start somewhere... *The Royal Road to Riches* is the first step in the right direction!

National Examiner:

John Wright has an excellent guide for achieving wealth in your spare time.

Income Opportunities:

The Royal Road to Riches is an invaluable guide for finding success in your own back yard.

News Tribune:

Wright's material is a MUST for anyone who contemplates making it as an independent entrepreneur.

Success!

John Wright believes in success, pure and simple.

Money Making Opportunities:

John Wright has a rare gift for helping people with no experience make lots of money. He's made many people wealthy.

Hollywood Trade Press:

We have never heard of an advertiser offering to pay readers \$20 to try its program. Wright's willingness to do this convinces us that his money secret must really work.

California Political Week:

...The politics of high finance made easy.

Hollywood Citizen News:

He does more than give general ideas. He gives people a detailed A to Z plan to make big money.

The Desert Sun:

Wright's *Royal Road to Riches* lives up to its title in offering an uncomplicated path to financial success.

When you use this secret to make money you never have to try to convince anybody of anything. This has nothing to do with door-to-door selling, telephone solicitation, real estate or anything else that involves personal contact.

Everything about this idea is perfectly legal and honest. You will be proud of what you are doing and you will be providing a very valuable service.

It will only take you two hours to learn how to use this secret. After that everything is almost automatic. After you get started you can probably do everything that is necessary in three hours per week.

PROOF

I know you are skeptical. That simply shows your good business sense. Well, here is proof from people who have put this amazing secret into use and have gotten all the money they ever desired. Their initials have been used in order to protect their privacy, but I have full information and the actual proof of their success in my files.

'More Money Than I Ever Dreamed'

"All I can say — your plan is great! In just 8 weeks, I took in over \$100,000. More money than I ever dreamed of making. At this rate, I honestly believe, I can make over a million dollars per year."

A. F., Providence, R.I.

'\$9,800 In 24 Hours!'

"I didn't believe it when you said the secret could produce money the next morning. Boy, was I wrong, and you were right! I purchased your *Royal Road to Riches*. On the basis of your advice, \$9,800 poured in, in less than 24 hours! John, your secret is incredible!"

J. K., Laguna Hills, CA

'Made \$15,000 In 2 Months At 22'

"I was able to earn over \$15,000 with your plan — in just the past two months. As a 22 year old girl, I never thought that I'd ever be able to make as much money, as fast as I've been able to do. I really do wish to thank you, with all of my heart."

Ms. E. L., Los Angeles, CA

'Made \$126,000 In 3 Months'

"For years, I passed up all the plans that promised to make me rich. Probably I am lucky I did — but I am even more lucky that I took the time to send for your

material. It changed my whole life. Thanks to you, I made \$126,000 in 3 months."

S. W., Plainfield, IN

'Made \$203,000 In 8 Months'

"I never believed those success stories... never believed I would be one of them... using your techniques, in just 8 months, I made over \$203,000... made over \$20,000 more in the last 22 days! Not just well prepared, but simple, easy, fast... John, thank you for your *Royal Road to Riches*!"

C. M., Los Angeles, CA

'\$500,000 In Six Months'

"I'm amazed at my success! By using your secret I made \$500,000 in six months. That's more than twenty times what I've made in any single year before! I've never made so much money in such short time with minimum effort. My whole life I was waiting for this amazing miracle! Thank you, John Wright."

R. S., Mclean, VI

As you can tell by now I have come across something pretty good. I believe I have discovered the sweetest little money-making secret you could ever imagine. Remember — I guarantee it.

Most of the time, it takes big money to make money. This is an exception. With this secret you can start in your spare time with almost nothing. But of course, you don't have to start small or stay small. You can go as fast and as far as you wish. The size of your profits is totally up to you. I can't guarantee how much you will make with this secret but I can tell you this — so far this amazing money producing secret makes the profits from most other ideas look like peanuts!

Now at last, I've completely explained this remarkable secret in a special money making plan. I call it "The Royal Road to Riches". Some call it a miracle. You'll probably call it "The Secret of Riches". You will learn everything you need to know step-by-step. So you too can put this amazing money making secret to work for you and make all the money you need.

To prove this secret will solve all your money problems, don't send me any money, *instead postdate your check for a month and a half from today. I guarantee not to deposit it for 45 days. I won't cash your check for 45 days before I know for sure that you are completely satisfied with my material.*

\$20.00 FREE!

There is no way you can lose. You either solve all your money problems with this secret (in just 30 days) or you get your money back *plus \$20.00 in cash FREE!*

Do you realize what this means? You can put my simple secret into use. Be able to solve all your money problems. And if for any reason whatsoever you are not 100% satisfied after using the secret for 30 days, you may return my material. And then I will not only return your original **UNCASHED CHECK**, but I will also send you an *extra \$20.00 cashiers check* just for giving the secret an honest try according to the simple instructions.

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WOODWORKING GUIDE

CHAIRMANSHIP

and lightly soften all sharp corners. Then, stain and varnish to match the dining table.

Our seat is constructed of a $\frac{3}{8}$ -in.-thick plywood base and three layers of $\frac{1}{2}$ -in.-thick foam rubber. Make a cardboard template of the seat base that leaves about $\frac{1}{16}$ in. all around for fabric clearance. Then, trace this onto the plywood and cut with a sabre saw. Starting at the front edge, staple a roughly sized piece of fabric to the underneath side of the plywood. Keep the fabric taut as you go. Next, fasten the fabric at the back corners while holding it taut front to back and corner to corner. Finally, fold over the remaining fabric and staple in place. It's best to use upholstery fabric that's been treated to repel stains. If not, apply Scotch Guard spray, available at most fabric outlets, to protect the seat. You can use our fabric (noted in the materials list) or choose a design that suits your own interior decorating scheme. Fasten the seat in place with four $2\frac{1}{2}$ -in. No. 10 f/s screws to complete the chair.

PM



11 Three bar clamps are all that's required to hold the completed assembly together. Let the glue dry overnight.



12 Complete the frame by gluing the corner blocks in place. Diagonal braces, glued and screwed to the rails provide rigidity.

The Gift

"If you need anything 'round these parts, Chester Lewis is the man to see. He's got everything. Including your mail. And what he doesn't have, he can get."

So what do you give the man who has everything? As usual, me and the boys decided on the smoothest sippin' whisky in Tennessee or any other place. George Dickel. Knowin' full well that Chester, as usual, would share it. And we all agreed, there ain't nothin' better."

Merle Haggard

DECEMBER

Cascade Hollow, Tennessee

		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		



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INJECTION AND OUR UNBEATABLE 7/70 PROTECTION PLAN,*
THERE'S JUST NO DOUBT ABOUT IT... DOWNTOWN OR DOWN 'N
DIRTY, IT'S GOTTA BE A DODGE RAM PICKUP.

7/70



**IT'S
GOTTA BE A
DODGE.**

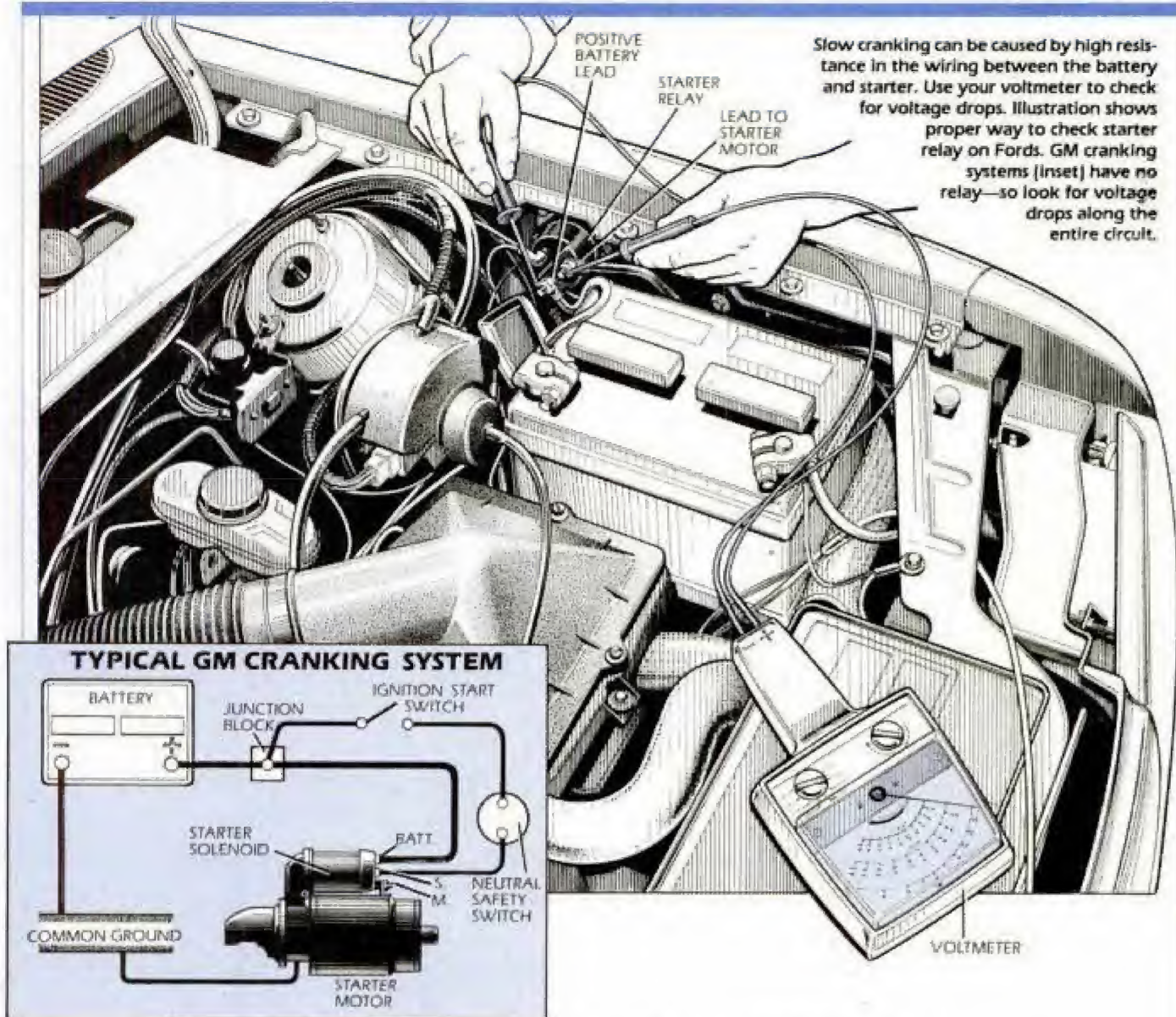
DIVISION OF CHRYSLER MOTORS



*See 7/70 powertrain & 7/100 outer body rust-through limited warranty at dealer.
Restrictions apply. Some features & engines not available on all models.

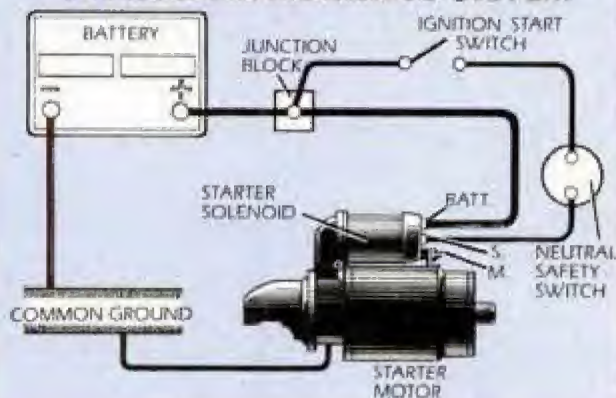
BUCKLE UP FOR SAFETY.

SATURDAY MECHANIC



Slow cranking can be caused by high resistance in the wiring between the battery and starter. Use your voltmeter to check for voltage drops. Illustration shows proper way to check starter relay on Fords. GM cranking systems (inset) have no relay—so look for voltage drops along the entire circuit.

TYPICAL GM CRANKING SYSTEM



What To Do When Your Car Won't Crank

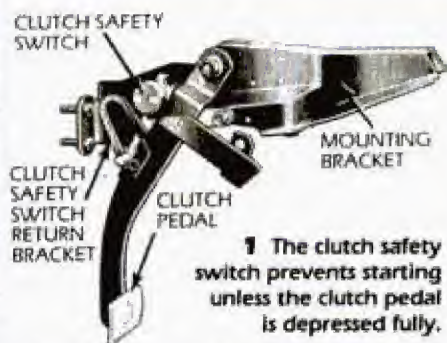
BY PAUL STENQUIST

You hop in behind the wheel, twist the key. Nothing. You try again. Nothing. The battery's probably dead. So, you check battery voltage with your voltmeter and level of charge with your hydrometer or the built-in hydrometer of a maintenance-free battery. The battery has plenty of juice, so you twist the key once more. Dead. It's got to be the cranking system.

What's going on here?

Cranking the engine is the toughest job on the battery. A tremendous amount of current—as much as 300 amps for some engines—is applied to the task of turning the engine fast enough to fire. A heavy cable joins the starter's positive circuit to the battery. Ground is maintained through the engine and battery ground strap and the starter's case.

A second low-amperage circuit is provided for the job of switching the current on and off. It turns the high-amperage starting circuit current on by means of a relay that on some cars is separate from the starter—on others it's on or in the starter. Most GM cars use a solenoid switch mounted either internally or on the outside of the starter motor. Most Fords, AMC and some imports have a



relay switch mounted in the engine compartment, usually on a fenderwell. Most Chryslers have both a solenoid switch and relay.

On some cars with solenoids, including all GM, the solenoid not only turns on the cranking current but engages the starter drive pinion with the flywheel. This type is called a solenoid-actuated starter. Cars with relays have a separate device inside the starter to engage the flywheel. On Chryslers with both a solenoid switch within the starter and a relay mounted in the engine compartment, cranking circuit current is turned on and off by the solenoid. Switching circuit current is turned on and off by the relay for a 2-tier switching circuit. The relay mounted on the fenderwell is sometimes called a *solenoid*. We'll call it a relay to keep from confusing it with the solenoid mounted on the starter.

When the key is moved to the START position, the low-amperage circuit is closed and current flows to the solenoid or relay—if the safety switch is in the right position as well. With an automatic transmission, the safety switch is closed when the selector lever is in NEUTRAL or PARK. With some manual transmissions, the safety switch is closed when the clutch is depressed (Fig. 1). The safety switch can be either of two types. One type completes the positive circuit to allow cranking when the transmission is in the right gear or when the clutch is depressed. The other type completes the ground side of the circuit.

Starting system requirements

Unless several things happen, the engine won't spin when you turn the key.

- The battery has to provide sufficient voltage.

- The key switch has to close the switching circuit between the battery and the solenoid switch or relay.

- The neutral or clutch safety switch has to complete the same circuit.

- The current that flows through this circuit must then close the solenoid switch or relay.

- The solenoid or starter actuator must push the starter motor's pinion gear into engagement with the flywheel ring gear.

- The starter motor must respond to the voltage applied and begin turning.

If a failure occurs in any one of these areas, one of four things may happen.

First, nothing at all occurs.

Second, you hear only a clicking or buzzing noise.

Third, the engine spins but not fast enough to start the car.

Fourth, you hear a whirring noise, but the engine doesn't spin.

In the following sections we'll discuss each type of failure.

Precautions

You want to prevent the car from starting while you're troubleshooting, so disconnect the hot lead to the coil.

Disconnecting the hot lead will also prevent burning up the points by leaving the ignition on while you're tinkering—if your car still has points.

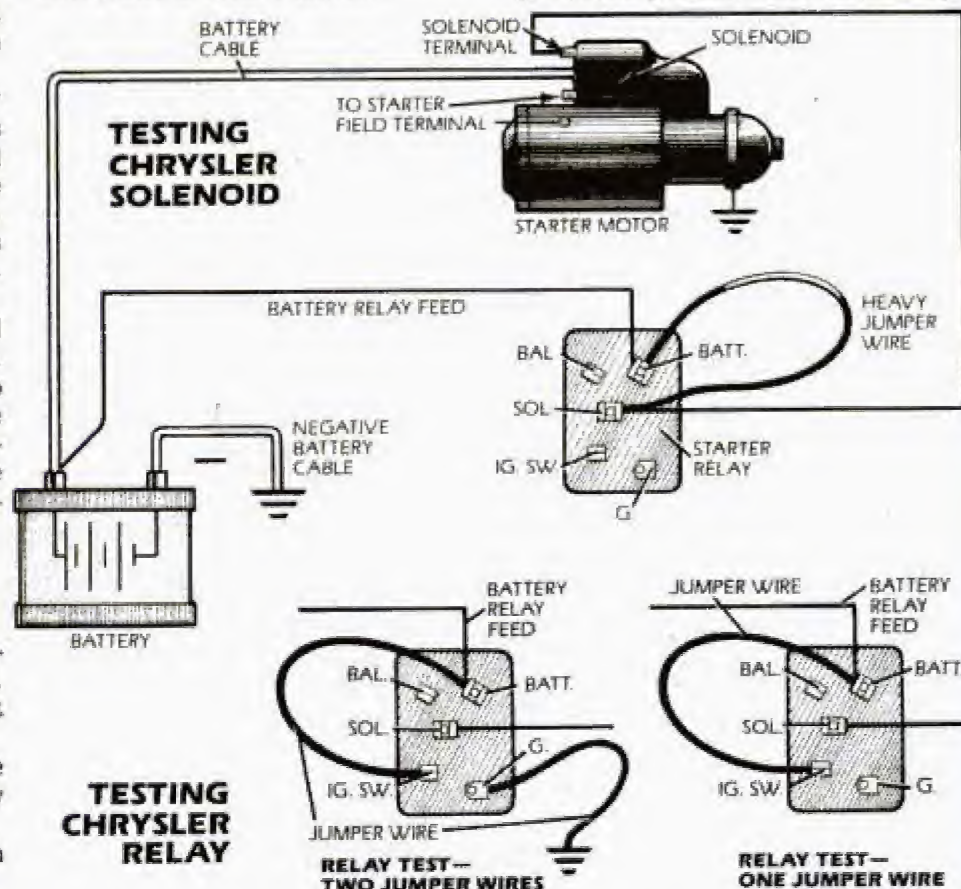
If you have electronic ignition, find out the proper way to disable the ignition, since there's the potential for damage to electronic components if the wrong wire is open or shorted.

Sound of silence

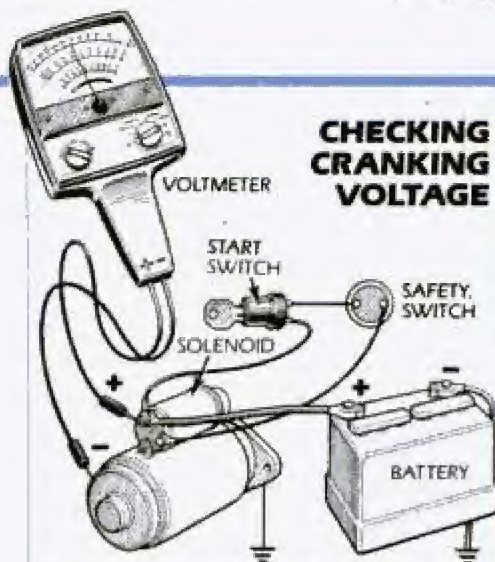
Assuming your battery isn't discharged, "dead silence" can be caused by an open connection in the switching circuit wiring or a bad solenoid or relay. It is usually *not* caused by a bad starter—unless of course both solenoid/relay and starter are defective. When only the starter is shot you usually get a pronounced relay or solenoid "click" when the cranking circuit is switched on.

To determine which part of the switching circuit is at fault on cars with a starter relay and no solenoid switch (including most Ford and AMC), jump the battery and ignition switch terminals of the relay. If the car has a manual transmission, have a helper depress the clutch pedal. If the engine doesn't crank, check to see if the relay has a ground terminal. If it does, leave the first jumper in place and connect a second jumper between the ground terminal and a good chassis ground. If the engine cranks now, the clutch or neutral safety switch is defective or out of adjustment. If the engine still doesn't crank, the starter relay is shot.

If the engine cranked when you installed the first jumper, the no-crank problem is probably caused by voltage



2 Troubleshoot Chrysler systems by jumping terminals, first bypassing the relay (top), then ignition switch (above right) and finally safety switch (above left).



CHECKING CRANKING VOLTAGE

3 Use voltmeter on 20-volt range to monitor voltage while cranking engine.

not reaching the relay. On cars with circuit breaker-type safety switches, try installing a jumper around the switch.

If jumping the neutral or clutch safety switch doesn't help, check to see if voltage is reaching the input side of the safety switch with the key in the crank position. If it isn't, there's a problem in the wiring, or your ignition switch is defective. If the warning lights switch on when you turn the ignition key to the RUN position, voltage is reaching the switch itself or the wiring between the ignition switch and the safety switch.

On Chryslers with both a solenoid and relay, connect a heavy jumper wire on the starter relay between the battery and solenoid terminals (Fig. 2). (On cars

with a manual transmission have a helper depress the clutch pedal.) If the engine cranks, the solenoid is good.

Once you're sure the solenoid is okay, check the relay by jumping between the relay's battery and ignition terminals. If the engine cranks, the starter relay is good as well.

If connecting the Chrysler's battery and ignition terminals won't make the engine crank, connect a second jumper on the starter relay between the ground terminal and a good ground. If the engine cranks, the starter relay is good, but the safety switch is defective or misadjusted, the ignition switch is bad or there is a problem in the switching circuit wiring. If the engine still doesn't crank, the relay is probably defective.

On cars with a solenoid switch and no starter relay, including GM, connect the ignition switch or "S" terminal on the solenoid to the battery terminal on the solenoid with a jumper wire. If this causes the engine to crank, the solenoid is not at fault. Check the neutral safety and ignition switches.

Clicking noise

If you heard the solenoid and/or relay click or buzz when you tried to start the engine but the starter didn't turn, the cranking circuit is being switched on, so either the starter is defective or insufficient voltage is reaching it.

To check cranking voltage, connect the positive lead of your voltmeter to the terminal on the starter where the

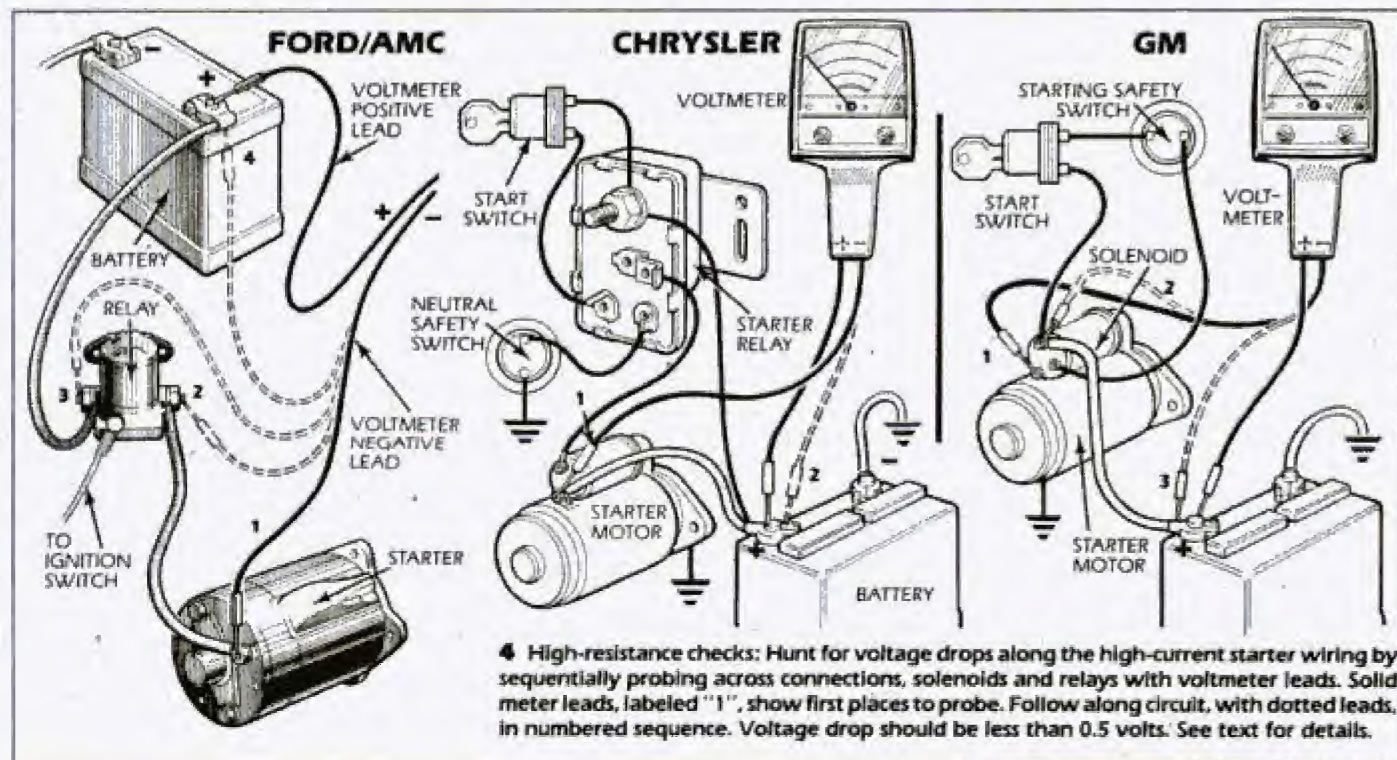
high-amperage battery cable attaches. Connect the negative lead to the starter housing (Fig. 3). Then crank the engine while you watch the voltmeter. You should see more than 9 volts. If you do and the starter won't turn or turns very slowly, it is probably defective. If you get less than 9 volts and you know for certain that the battery is okay, circuit resistance may be excessive.

Pinpointing high resistance

Check the positive circuit first. Connect the positive lead of your voltmeter to the center of your positive battery post—not to the cable terminal. On GM cars, connect the negative lead to the terminal on the solenoid that is joined to the starter motor with a heavy copper strap. You'll find this terminal on the lower part of the solenoid, right above the starter housing. On Chryslers and Fords, connect it to the terminal on the starter or solenoid where the positive battery cable attaches.

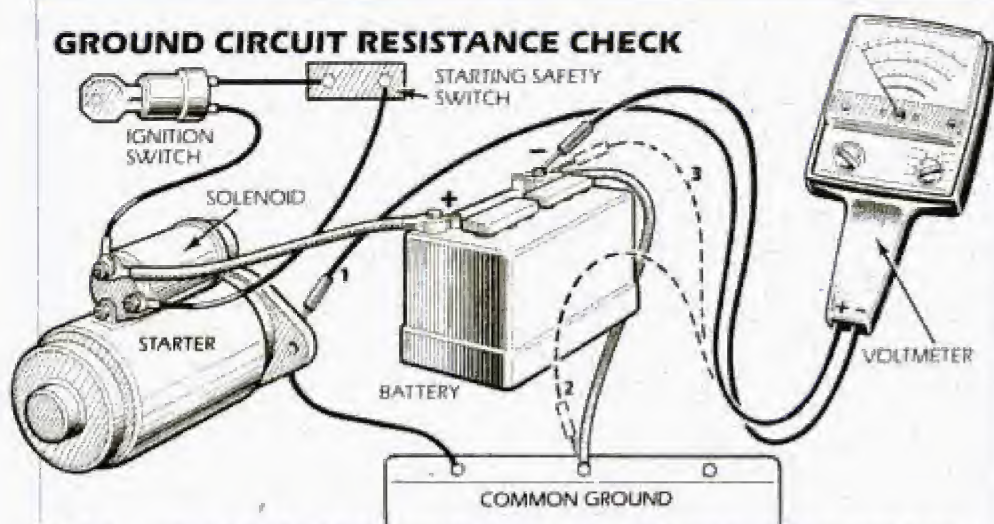
Attempt to crank the engine with the voltmeter attached. It should show less than 0.5 volt. If it does show less than this figure, high resistance is not the cause. Continue with the negative circuit resistance test below.

If positive circuit resistance is above 0.5 volt, check voltage drop at other locations, each one somewhat closer to the battery. Starting at the positive battery post and starter terminal move successively closer to the battery with the neg-



4 High-resistance checks: Hunt for voltage drops along the high-current starter wiring by sequentially probing across connections, solenoids and relays with voltmeter leads. Solid meter leads, labeled "1", show first places to probe. Follow along circuit, with dotted leads, in numbered sequence. Voltage drop should be less than 0.5 volts. See text for details.

GROUND CIRCUIT RESISTANCE CHECK



5 If the positive side of the starter circuits passes muster, start chasing after voltage drops in the negative, or ground side, with your voltmeter. Voltage drop should be less than 0.3 volts.

active lead (following the step numbers on Fig. 4). When you reach a point where the drop is acceptable, you know that the defect is between that point and the last location where you tested.

On GM cars, the second place to test is where the battery cable attaches to the solenoid. If voltage drop is within limits here, but was excessive at the first testing point, the solenoid must be replaced. This is a fairly common problem and is a likely cause of either no-crank or slow-crank conditions.

On Fords or AMC cars with a relay in the high-amperage cranking circuit, make your second check at the high-amperage terminal on the starter side of the relay. If voltage drop is okay here, but was excessive at the starter terminal, then either the cable connections are loose or corroded or the cable joining the relay and starter is defective and should be replaced (or perhaps the connections are loose). If voltage drop is still excessive, make your third check at the high-amperage terminal on the battery side of the relay. If voltage drop is within limits at this point, but was excessive on the starter side of the relay, then the relay itself is the source of the high resistance and must be replaced. (See lead illustration on page 137.)

On all vehicles, if you haven't located the cause of the high resistance in previous measurements, make your last voltage-drop check on the battery terminal (voltmeter positive lead on the battery post, negative lead on the terminal). If the drop is excessive at the terminal, then corrosion or a poor fit between the post and terminal is the problem.

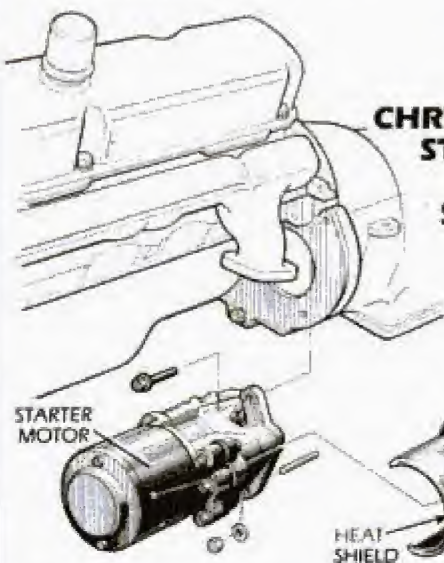
Perform a similar test to check ground circuit resistance, connecting the negative voltmeter lead to the negative battery post and the positive lead to the starter housing (Fig. 5). Attempt to

crank the engine and note voltage drop. On most cars it should be less than 0.3 volt. Continue testing at other points in the ground circuit, such as where the ground strap joins the engine to the battery or chassis, the point where the battery ground strap attaches and, finally, at the battery's negative terminal.

If ground circuit voltage drop is less than 0.3 volt and positive circuit drop is less than 0.5 volt, high circuit resistance is not the cause of the cranking problem. In this case, it could be that cranking voltage was low because the engine is tight, or a defective starter.

Slow cranking

An internal engine problem might affect starting when the engine is very hot and pistons are expanded. Some manufacturers provide a torque specification for engine cranking with a torque wrench on the front pulley bolt.



6 Chrysler starter for 318 engine has heat shield that must be removed to replace starter. GM starters (inset) may or may not need to be shimmed when they're replaced.

Excessive ignition advance can also cause slow cranking. Sometimes the engine will speed up after a few revolutions. Make sure that timing is set to the carmaker's specification before condemning a starter for slow crank. On cars with a mechanical advance mechanism, make sure the centrifugal weights are not sticking.

Whirring noise

If you hear the starter motor running when you turn the key to the START position but the engine doesn't crank, the over-running clutch is probably not engaging. This clutch, sometimes called the "Bendix" or starter drive, engages when pressure is applied in one direction. It's designed to prevent the running engine from turning the cranking motor. If the clutch fails to engage, the starter will spin but not turn the engine. Once the starter has been removed from the car, you can check for a faulty clutch by attempting to turn the pinion in both directions. It should turn freely in one direction, but not at all in the other.

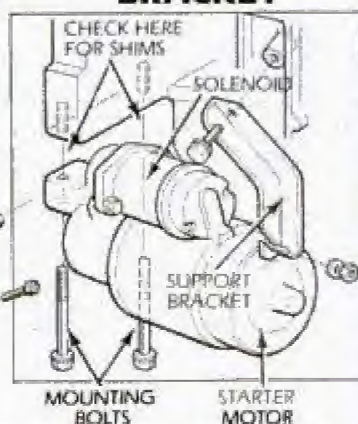
Starter replacement

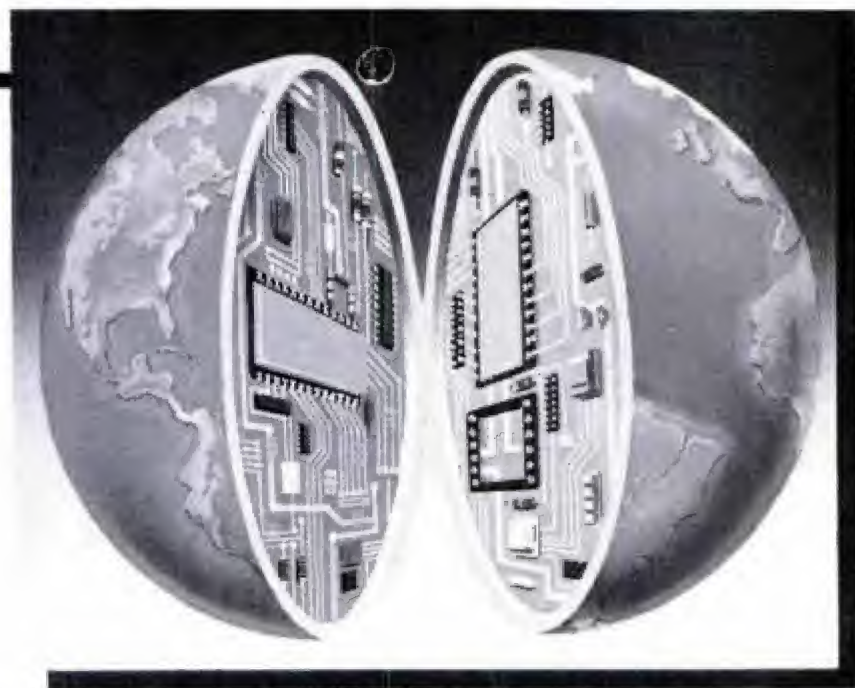
Disconnect the battery's negative ground strap before attempting to remove the starter. Some starters are covered with a heat shield that must be removed for access (Fig. 6). On GM cars, check for shims under the starter mount. These determine pinion-to-fly-wheel clearance and should be reinstalled with the new or rebuilt starter. There will be instructions for measuring correct clearance, and probably extra shims with your replacement starter.

If there are no shims to remove, the pinion can be moved closer to the fly-wheel by using a different type of shim on the outboard starter mount. **PM**

CHRYSLER 318 STARTER HEAT SHIELD

GM SUPPORT BRACKET





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5 MILLION SMILES

(Continued from page 78)

engine idle for 30 seconds before shut-down to let the turbo cool. For 1987, the turbo became watercooled, so owners of later cars didn't have the problem. A few felt, though, that the turbocharged engine's 3750-mile service interval seemed a bit bothersome. Those who changed oil themselves reported good access to the drain plug and filter.

While no one criticized Saab's 4-wheel disc brakes directly, 6.0 percent of owners felt a sports sedan of this type should offer antilock braking. Saab says an ABS system is in the works and will be available soon.

Despite handing the 9000 a big bouquet for workmanship (98.7 percent *good to excellent*), nearly half of our respondents did report mechanical problems. Of those, 28.7 percent were electrical, many having to do with the pictograph screen. Other aggravations: "Parts and service are unbelievably expensive," opined a New Yorker banker. A California oral surgeon reported paying \$240 for his 12,500-mile checkup and \$450 at 22,500 miles.

In all, dealer service disappointed nearly 20 percent of our respondents. A Michigan engineer told us, "I feel the complexity of this automobile is far beyond the abilities of the current level of skill of technicians to repair it." And a California manager who wanted to avoid the dealer entirely asked, "Did you know that the Saab 9000 shop manual comes in four volumes for \$100?"

Weak liftgate struts, especially when cold, made opening the fifth door a minor challenge for some people. Another challenge involved the manual shifter. An Ohio attorney commented, "Gearbox not quite perfect—very tight, often

grinds going into reverse. Reverse is also hard to find."

But the cheers easily drowned out the jeers. "Finest engineered auto in this price range on the road today," affirmed a Florida retiree. An Arizona lawyer summed it up this way: "I love it. My Turbo is very quick, very economical, very roomy inside but compact outside. It's a great car in snow. It turns heads. It isn't nearly so common as Beemers, Benzes and Volvos, yet it's a better buy than any of those cars."

Pontiac Bonneville

It's no secret that Pontiac, more than any other GM car division, wants to compete seriously with the makers of European and Japanese sports sedans. Pontiac actively courts buyers who might otherwise consider a Volvo or an Audi, a Saab or small BMW, and even those who slam doors and kick tires on the less expensive Mercedes.

Pontiac produced a good study of European handling, performance and styling with the 6000 STE back in 1983. Now comes the Bonneville, which takes another step toward the Euro look and feel in a slightly larger format.

In developing the Bonneville, Pontiac engineers scrutinized all the more popular European makes, plus a handful from Japan, including the Honda Accord. The idea was to offer Americans at least the *emotional* appeal of these sports sedans. And the way Pontiac decided to do it was first to give the Bonneville a European look and then to make it handle, ride, perform and fit together like cars built overseas. Its low nose, its high rump and its clean, functional interior do give it a foreign accent.

Even so, there's a red-white-and-blue heritage that the Bonneville can't get around. It shares GM's H-Car platform

with the Buick LeSabre and Olds Delta 88. As such, it uses the same Buick-built 3.8-liter MFI V6 (and for the '88 model year, the 3800 sequential fuel injection V6 is available, too), the same fwd over-drive automatic transaxle, the same inner body shell and roof structure.

Pontiac's challenge was to Europeanize the basically conservative, stodgy H-Car exterior by tailoring a new suit of clothes. This resulted in giving the Bonneville unique front and rear sheetmetal, unique outer door skins, and a totally different-looking interior.

At the same time, Pontiac built in enough European icons to rival its continental competition.

For example, the Bonneville's optional SE package includes a firmer suspension system, full gauges, reclining front seats, a growler exhaust note, and wider tires on 15-in. alloy wheels. For '88, the SSE adds full wraparound, aero ground effects bodywork.

You might think that Pontiac had the young, upwardly mobile executive in mind when they tweaked and groomed the Bonneville. You'd be wrong, too, and maybe Pontiac's market planners got the same sort of surprise, because interestingly, according to our survey, Bonneville buyers are mostly senior citizens. It turns out to be the all-American retiree's sports sedan. Fully 43 percent of our respondents gave their age as 60 and older.

Yet the same things that attract younger buyers drew those older buyers into the showroom. They very much liked what they saw. A Michigan retiree told us, "The Bonneville looks like it's moving when it's parked!" A retired Minnesotan added, "A stylish, elegant, and beautiful automobile." (Owners comments refer to their 1987 models

(Please turn to page 144)

PONTIAC BONNEVILLE OWNERS REPORTS*

Total miles driven	1,275,857	Power Economy	26.9	Excellent	58.8%	Poor	4.0
Average miles per gallon:			22.4	Good	33.6		
In town	20.8			Average	4.7	Number of vehicles owned:	
On the highway	27.2	Specific dislikes:		Poor	2.8	This car only	36.8%
Series choices:		No complaints	19.2%	Rear seats:		Two cars	42.8
Bonneville LE	56.5%	Exhaust system too loud	9.2	Excellent	49.2%	Three cars	14.2
Standard Bonneville	43.5	Seat uncomfortable	7.9	Good	45.5	Four or more cars	6.2
Option choices:		Glovebox too small	6.1	Average	4.7	Makes of other cars owned:	
Driver information center**	49.1%	Upholstery material holds lint	5.2	Poor	0.7	Pontiac	40.3%
Rally Tuned		What changes would you like?		Had any mechanical trouble?		Chevrolet	28.9
sport suspension**	40.8	No changes	36.6%	No	63.6%	Buick	11.9
SE option group	32.4	Different seats	6.4	Yes	36.4	Oldsmobile	8.5
Electronic ride control	20.5	Different instrument layout	5.7	What type of trouble?		Cadillac	7.5
Sunroof	1.7	Larger glovebox	5.7	Electrical system	24.6%	Would you buy a Bonneville again?	
Why did you choose the Bonneville?		Quieter exhaust	5.3	Intermittent short in horn	14.0	Yes	72.8%
Styling	60.9%	How much did you pay?		Engine stalls	11.4	Maybe	21.0
Owned Pontiacs before	25.8	Average	\$15,832	Cruise control	7.0	No	4.2
Handling	15.2	Range	\$13,100-\$19,439	ECR valve/transmission	6.1	Would you buy a Pontiac again?	
Ride	13.9	Workmanship opinion:		Dealer repairs satisfactory?		Yes	64.8%
Performance	10.6	Excellent	51.8%	Yes	74.0%	No	26.6
Specific likes:		Good	42.0	No	26.0	Maybe	4.7
Styling	50.8%	Average	3.9	Dealer service opinion:		Age distribution of owners:	
Handling	40.2	Poor	0.3	Excellent	44.2%	Under 29 years	3.2%
Ride	32.5	Comfort opinion:		Good	41.8	30-49	31.1
Comfort	30.8	Front seats:		Average	10.0	50-plus	65.8

*Percentages might not equal 100% due to rounding or an insufficient amount of data.

**Included as part of SE option group.

The standard equipment on a Laser 128 is optional on most computers



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Choose from the largest software library in the world. The Laser 128 runs Apple IIe and IIc software, which makes it nice for you and your family, because children can use the same programs at home that they learn on in school. The Laser 128 is a computer for the whole family.



The Laser 128 has built-in interfaces for all

your peripherals, including serial and parallel printer interfaces, modem and mouse interfaces, a game port and you can hookup a



color or monochrome monitor, or even a TV to it. Only the Laser has this much built-in as standard equipment.



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5 MILLION SMILES

(Continued from page 142)

since our survey was conducted before the '88 Bonnevilles went on sale.)

"It's a sharp-looking car at a reasonable price," stated a Michigan accountant, "not too big, not too small, with good fuel mileage and a huge trunk."

Nearly everyone appreciated the Bonneville's roominess. A North Carolina financial manager observed, "Excellent car for large adults. I'm 6 ft. 6 in. and have two sons 6 ft. 2 in. and 6 ft. 3 in., and we all fit fine." A California serviceman: "This Bonneville truly fulfills the American dream of a European car. My 6-ft. 9-in. son has no trouble entering and exiting, driving the car or operating the controls."

And while comfort and convenience generally got good marks, we did hear a few scattered complaints. "The front seatback tilts too far rearward in its permanent position," groaned an Ohio restaurateur. A Wisconsin apartment manager suggested, "A small point, but this car needs a place to store cassette tapes. You can't put anything on top of the dashboard, the glovebox is too small, and things keep falling out of the door storage bins." And an Iowa buyer: "Radio control buttons are too small, and the heater slide is hard to adjust for the right temperature."

Other minor gripes concerned the position of the odometer (off by itself to the right of the speedo), lint-holding seat upholstery, and the expense of replacing a temperature gauge. "This was done under warranty," noted a Mississippi sales rep, "but I got a copy of the bill. The heat gauge stuck on 260° and the dealer had to order a whole new instrument cluster, which took 3 weeks to arrive and cost \$1800, just to replace one gauge!"

Most owners were pleasantly surprised with the Bonneville's get-up-and-go. A Michigan program analyst put it this way: "Lemme tellya, it moves!" "Quickest car I've ever owned except for a Corvette," marveled a Michigan springmaker. "The car responds quickly," voiced a Mississippi vice president, "with excellent acceleration that doesn't sacrifice gas mileage. The injected V6 works great!"

(Owners of '88 Bonnevilles with the new 3800 V6 will get 15 more horses for 165 at 5200 rpm.)

And a Wisconsin retiree confided, "The Bonneville has front-wheel drive, which we like. We were visiting Nebraska last winter, and coming home we ran into the first big snowfall of the season: heavy, wet, deep, slippery snow. Many cars were off in the ditch, but we made it all the way and were very pleased with how our car performed in the storm."

Fuel economy, too, stood out as one of the Bonneville's best-liked features. A South Carolina sheriff told us, "Just returned from a trip and couldn't believe the gas mileage. Checked it at five different filling stations and came up with the same figure every time: 32.5 mpg on the highway. This is outstanding for a car of the Bonneville's size, especially with so much comfort and excellent performance. I'm very impressed."

Overall, the Bonneville delivered 20.8/27.2 mpg city/highway, slightly better than the EPA's 18/27 estimate.

Workmanship received another high rating in our survey, with 95.8 percent giving it a score of *good to excellent*. A Maine machinshop supervisor said, "I have yet to find any flaws and, believe me, I've looked hard. So far I'm extremely satisfied with my Bonneville." An Alabama teacher: "Tight as a jug!" An Ohio supervisor: "Best styled car GM has had in years, and it also has the highest quality."

Only about a third of our owners had to bring their cars back for service, and most repairs were minor. In a few early models, the horn would honk itself at odd times. Two or three owners complained that the engine oil filter was hard to get at. But 63.6 percent reported no troubles of any sort. A Minnesota analyst: "No mechanical problems yet. Fewer fit/finish flaws than previous GM cars I've owned."

The Bonneville's ride and handling likewise pleased most owners. "I am really impressed with the cornering ability of so large an automobile. It brings back the joy of driving," smiled a Kentucky project manager.

"Handles so well," concurred an Iowa meat packer, "that you don't get tired of driving it." A Texas housewife affirmed, "The Bonneville is a dream to handle and drive. It has room for the family and might look like a big car, but it handles like a small one." A Michigan salesman: "This car rides better than the Lincoln Town Car we used to have and it handles like a Mercedes."

Several owners felt the Bonneville to be a little too sporty and too European for their tastes. This sometimes happens when people buy new cars that mark a departure from the smooth, power-accessorized American sedans they were used to. "Steering effort could be a little lighter," wrote a Michigan engineer.

Even so, most owners were very pleased with their cars. We'll leave the final word to a Wisconsin banker, who summarized the Bonneville by saying, "This is one fantastic American-built automobile. Pontiac has adopted some proven European design and engineering features, but it's truly an American car, with excellent power and comfort and economy."

PM

A family solves their water shortage problem

How I Drilled A Well

MARY HICKMAN

MY FRIENDS THOUGHT I had lost my mind. The idea that the children and I could drill a water well by ourselves sounded like an impossible dream. However, we live out in the country, and we had to have more water for the livestock and our large garden.

We had already tried to drive a well point, but the ground here is so hard we could hammer it down only a few inches a day. Finally, I told the kids, "Look, I know there's water down there somewhere and I'm determined to get it, but there's just got to be an easier way."

I had ruled out hiring a commercial driller when I found he would have to cut down some of my beautiful trees to set up his big drill where I wanted a well. Also, I found that commercial drilling is expensive, very expensive.

AN EASIER WAY

Then I saw an advertisement that claims that you can drill your own well with a Hydra-Drill and save a lot of money. Now, I had never drilled a well before. In fact, I had never even watched a well being drilled, but I assumed it would be difficult for the children and me to handle. However, they offered a free brochure, so I requested it.

When the information came, I was delighted to find that it contained a wealth of material. In addition to pictures and descriptions of the equipment, there is a very informative booklet about drilling your own water well. Also, there is a recording by people all over the country discussing their experiences drilling Hydra-Drill wells.

I listened to the record and studied the information for several days. I was impressed, but I wondered what we would do if we ran into a problem while we were drilling. Then I thought — well, they have a free consulting service with a toll-free telephone. Any company that is willing to go out on a limb like that, knowing they'll get calls from all over must have a lot of confidence in their product. So I took a deep breath, crossed my fingers, and ordered a Hydra-Drill.

TWO SURPRISES

Much to my amazement, the Hydra-Drill arrived from the factory in Alabama just 7 days after I ordered it. That was my first surprise.

My second surprise was the simplicity and ease of operating the Hydra-Drill. Very quickly we discovered that for the most part, all we had to do was stand back and watch it work for us. Of course, the kids wanted to operate it, but there really



wasn't much for them to do. There isn't any big mess, and it's more like play than work. Best of all, we were drilling exactly where I wanted the well, and we didn't have to cut even one of my trees.

The instructions that come with the Hydra-Drill are clear and easy to follow, and I felt confident in what we were doing. However, just to be on the safe side, I called their toll-free consulting service and they were very helpful. They answered my question thoroughly and it was a good feeling to know they were available if I needed them.

SPARKLING CLEAR WATER

The biggest thrill came when we hit water. It was such an exhilarating experience, I can hardly describe it. We had actually done it! We had drilled deep down into the earth and found beautiful, sparkling clear, delicious water! I could hardly believe it. We're still on Cloud 9.

Looking back, the most surprising part is how easy it was. In the Hydra-Drill brochure, they talk about different drilling conditions and how to handle them, but we really had no problem at all. In fact, it was such fun the kids are eager to drill some more wells. We're so caught up in the excitement of it that we'll probably drill wells all over the farm just for the sheer fun of it.

It must be contagious, because my friends are getting caught up in it, too. When we started, they thought it was a pie-in-the-sky idea. Now they've got the well-drilling bug and I could sell my Hydra-Drill in a minute if I wanted to.

IF YOU ASK ME

To anyone considering drilling a Hydra-

Drill well, my advice is this: Sure, it's a challenge, but don't be afraid. It's an exciting and satisfying experience. If you ask me if I think it's worth doing, I'll say, "Yes, I do. I really do!"

NOTE: Readers can get a big, fully illustrated information kit on the Hydra-Drill including a booklet, "How to Drill Your Own Water Well". The information kit is available free, without obligation. Your request should be addressed to: DeepRock Manufacturing Co., Anderson Road, Opelika, Alabama 36802.

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BREAKING THE SOUND BARRIER

(Continued from page 92)

wind with thinning oxygen and mounting anticipation—we'd get X-1 ready for flight.

The drop itself was the next big obstacle, and like entering the bird, it's something that I never really got used to. During preflight checks, I'd practice neutralizing the controls and brace myself for the release. Cardenas would go through the countdown, finishing with an emphatic "Drop!" X-1 would float from the B-29 and I'd get launched right up to the cockpit overhead, caressing the canopy with my helmet in the sudden swell of microgravity. My heart was in my mouth, stomach right behind it.

The pilot's reports I wrote afterward were devoid of these sensations—as a professional test pilot, you were expected to maintain a coldly dispassionate tone. Consider these excerpts from the report following the eighth powered flight: "After pilot entry in the usual fashion at 7000 ft., the XS-1 was dropped from the B-29 at 20,000 ft. and at 260-mph indicated airspeed . . . Immediately after the drop, all cylinders were started in rapid sequence, and with all four in operation it was noted that No. 1 and No. 3 had 210-psi chamber pressure, No. 2 and No. 4 having 220 psi, with approximately 290-psi LOX and fuel line pressure . . . The climb was made at .85 to .88 Mach until 40,000 ft. was reached . . . The eighth flight on October 10 signaled enormous progress in the X-1 program. We thought it was only a matter of time before we'd push through the sound barrier. What would it be like? A pebble in the road of aviation we had merely to step over? Or an insurmountable Chinese Wall that would destroy X-1—and me with it? Naturally, thoughts at these moments turned to Glennis and my boys, who sacrificed plenty out in the desert in those brightly lit days of the late 1940s. I wanted to fly, wanted to take my shot at the speed of sound. And they were my own personal cheering section.

As I stood looking at my carrot, my glasses and my rope on the morning of October 14—broken ribs secretly knifing at my side—I thought that this just might be the day. The eighth powered flight had gone exceedingly well. We had flown as fast or faster than anyone ever had before. And it looked as though we only had to step over the line to enter aviation's new age. The day of the ninth powered flight began in the usual way. I fried the eggs while Glennis got ready to drive me over to the airfield. I'd had a bad night's sleep—from the pain in my side, but also from the indecision about whether or not to fly the mission incapacitated. Tossing and turning, I decid-

ed to make up my mind in the air. If it became physically impossible to climb into X-1, then I'd scrub the mission. If I could get into the pilot's seat, I knew I could fly.

As the team swarmed over X-1, cords from trouble lights dangling in the early morning gloom, tools, racks, ladders and other gear surrounding the little ship, Ridley began the preflight coaching. "We got that Drene shampoo for the windshield," he said, "so you shouldn't have any trouble with the windscreen frosting over. Now remember, you play around with the stabilizer setting before you make your high-speed run. We know you'll lose some elevator control. So find out where you get the most longitudinal control with the stabilizer. Try it at different settings and different speeds above .85 or .86 Mach." Discussions continued over coffee. There was a heightened intensity, a new determination, on the part of everyone involved. This was it. This was the day. Would it end with another record shattered? Or with failure's grim finality?

After X-1 was fueled, I returned to the ready room with Ridley to don my flight suit. Briefings continued, peppered by admonitions and warnings: "Under no circumstances are you to . . ." "In the event of . . ." "You'd better be sure to . . ." Their whole point was to make sure I didn't take X-1 over .96 Mach if I didn't think the plane could handle it.

Fear crouched in the deep recesses of the mind—present, accounted for, but well controlled. With the fueling and mating procedures completed, I walked back out to the B-29 and stooped low to make a last-minute check of X-1's instrumentation. Helmet and oxygen mask were well secured behind the seat, and I jogged to the boarding ladder and started climbing. Then it was the long quiet wait as the B-29's engines fired, the big bird began its takeoff roll and lumbered up to the drop altitude. I sat on a metal box inside the plane, ignoring my safety belt against the regulations. At 5000 ft., I nudged Ridley and said, "Let's go." We walked back to the bomb bay hatch and strode through. There was the little X-1, dangling in all that wind and cold and thinning air. Every move was torturous at this altitude. Getting into X-1 on a good day was tiring enough. But I struggled through, wanged the hatch closed with the help of a 10-in. piece of broom handle I'd fashioned for the purpose, owing to the limits imposed by my broken ribs, and continued checking X-1's pressurization, fuel delivery and controls.

Richard Frost, Bell project engineer, was flying low chase that morning, and Lt. Bob Hoover was flying high chase

(Please turn to page 148)

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BREAKING THE SOUND BARRIER

(Continued from page 136)

well ahead of the B-29, both in Lockheed P-80s. In the standard routine, Frost would fly about 1000 ft. above and behind the mother ship, and would nose over into a dive when Cardenas began the countdown, which would place him off X-1's wing when I was dropped from the bomb bay. Frost would pull into a slight climb as I lighted the first chamber, aiming for Hoover's P-80 about 10 miles ahead. I would try to pass Hoover at relatively close range as the fuel supply depleted, and he'd follow me down for an unpowered landing on the lakebed.

Everything was set inside X-1 as Cardenas started the countdown. Frost assumed his position and the mighty crack from the cable release hurled X-1 into the abyss. I fired chambers No. 4, then No. 2, then shut off No. 4 and fired No. 3, then shut off No. 2 and fired No. 1. The X-1 began racing toward the heavens, leaving the B-29 and the P-80 far behind. I then ignited chambers No. 2 and No. 4, and under a full 6000 pounds of thrust, the little rocket plane accelerated instantly, trailing a contrail of fire and exhaust. From .83 Mach to .92 Mach, I was busily engaged testing stabilizer effectiveness. The rudder and elevator lost its grip on the thinning air, but the stabilizer still proved effective, even as speed increased to .95 Mach. At 35,000 ft. I shut down two of the chambers and continued to climb on the remaining two. We were really hauling! I was excited and pleased, but the flight report I later filed maintained that outward cool: "With the stabilizer setting at 2°, the speed was allowed to increase to approximately .95 to .96 Mach number. The airplane was allowed to continue to accelerate until an indication of .965 on the cockpit Machmeter was obtained. At this indication, the meter momentarily stopped and then jumped up to 1.06 and this hesitation was assumed to be caused by the effect of shock waves on the static source..."

I had flown at supersonic speeds for 18 seconds. There was no buffet, no jolt, no shock. Above all, no brick wall to smash into. I was alive.

And although it was never entered in the pilot report, the casualness of invading a piece of space no man had ever visited was best reflected in the radio chatter. I had to tell somebody, anybody, that we'd busted straight through the sound barrier. But the transmissions were restricted. "Hey Ridley!" I called. "Make another note. There's something wrong with this Machmeter. It's gone completely screwy!"

"If it is, we'll fix it," Ridley replied, catching my drift. "But personally, I think you're seeing things." **PM**

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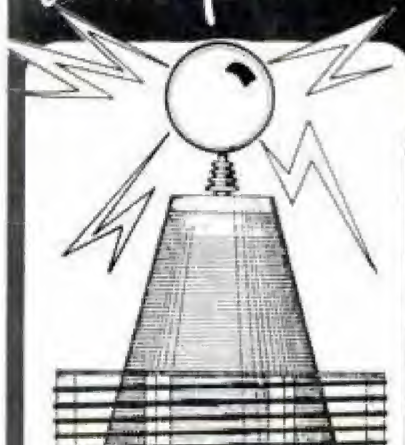
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POWER LIFTERS

(Continued from page 85)

importance," says John Mahoney of Hitachi Corp., one of the largest Japanese manufacturers of construction cranes. "Sparked by product liability problems, insurance rates have become horrendous."

Mahoney says his company is developing analog devices to monitor load stresses. These devices, he says, are "getting to be quite reliable." Hitachi has developed what amounts to a sound and light show to indicate the boundaries of load safety. While the operator hoists loads within safety margins he faces a green "idiot light." As a load is moved toward a dangerous radius, the light turns yellow and a beeper goes off. As the machine is pushed to overcapacity, the light turns red, horns blare and power cuts out.

Another safety innovation Mahoney expects in the future is a coded key lock system to prevent crane operation by unauthorized or untrained personnel.

In the actual hoisting department, Mahoney predicts that high-strength nylons, textiles like Kevlar, will replace chains for rigging loads to the hook, except in cases where sharp-edged surfaces could cut the fabric.

"Pound for pound," says Mahoney, "these materials are stronger than steel." High-strength steels are being tested for future use in wire ropes, "but maybe a Kevlar cable will even be possible one day," he says.

Mahoney says computers are being used to fine tune the design of crane components. Hitachi employs factory robotics to fabricate crane booms and towers. He says the company's engineers are working to make machines with less weight and better balances to perform higher lifts at faster cycle

times. Assisting the operator with improvements in the cab is also a Hitachi priority.

"Today, cabs are like expensive automobiles. They are big and roomy inside and soundproof. They have easy eye glass that is tinted to cut down on solar-radiated heat," says Mahoney.

Gary Vosper works for Seattle-based Morrow Crane, U.S. distributor for the West German company Liebherr-Werk Biberach, the world's largest builder of tower cranes. Vosper agrees with the need for cab improvements, and foresees enlarged windows for better visibility. He also predicts the replacement of mechanical load-indicating devices with computer-chip-based detection systems.

In contrast to New York City's upward growth, the urban construction trend is heading away from high-rises to medium-size buildings, according to Vosper, who says the growth in high-rise construction was prompted by real estate investments that have created a glut of office space.

Midrise buildings will dominate future urban construction, Vosper says—40 stories rather than 80, where the capabilities of mobile cranes and tower cranes overlap. Accordingly, he believes the future belongs to the self-erecting trolley jib tower crane, otherwise known as the fast-erect tower crane.

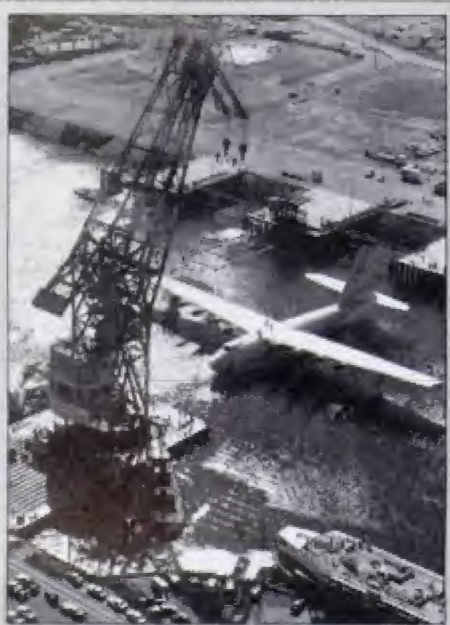
Self-erecting tower cranes combine the ability to work in cramped areas like conventional tower cranes, and the road-ready portability of conventional mobile cranes. Self-erecting cranes require no outside crane assistance for assembly and disassembly. Their ability to self-load and unload concrete counterweights makes special foundations unnecessary. A single operator can oversee the entire assembly or disas-

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Just call "Herman the German," considered by crane lovers to be the biggest floating crane on Earth. Built by the Germans during World War II, the 385-ton capacity, articulating jib crane was dismantled after the war and towed to its present mooring in Long Beach, California. It has been used by the U.S. Navy to lift everything from a battlewagon's main guns, to a nuclear reactor vessel, to Howard Hughes' Spruce Goose. The giant crane uses more than 2 miles of 1 1/2-in. wire rope on 13-ft. grooved drums.

It's said Herman can lower 100 tons down to touch an egg without breaking it. At 45, Herman the German is still going strong.—Chris Caswell

"Herman the German" hoists Howard Hughes' Spruce Goose.



sembly of the telescoping crane from ground-based controls.

Liebherr's self-erecting cranes, called Fasttower Cranes, are good examples of the type. They're currently offered in five models with capacities from 3660 to 24,440 pounds and heights ranging from 65 to 164 ft. Radii extend from 75 ft. to 147 ft.

These self-erecting midrise builders are making waves in an industry where little has changed in the basic technology of hoisting a load with a boom, a counterweight, a wire rope and a hook. In fact, the biggest competition to new cranes is coming from old cranes still pulling duty on the nation's construction sites.

Changes are taking place, however. Tower cranes are being built with greater capacity, speed and precision. Sealed bearings and pulleys, galvanized cables, cotters and bolts are substantially reducing the need for maintenance. By using tight-welded tubular steel in booms and towers, cranes are being built with more strength and less weight to increase capacity and improve balance.

The rail-basing of cranes will increase, eliminating the need to lay a foundation in each spot where a tower crane is erected, increasing the utility of a single crane tower at a job site.

The increasing application of hydraulics to crane technology will reduce the amount of electric power that must be brought to the job site. Hydraulic joystick controls will enable the operator to accelerate, decelerate and position loads more precisely than today's electromechanical cable-driven controls.

Developments in more durable, solid-state indicating devices will considerably upgrade the safety and efficiency of crane operations. Computer processors in crane cabs and backup indicating systems will increase the operator's ability to accurately assess load weights and soil and wind conditions. Operators will be able to refigure load equations as conditions change.

New sensors will also be developed to cut out power before cranes come into contact with electric power lines, or when misreeving on a wire rope drum is imminent.

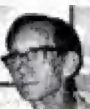
Complicated security lock systems will be installed in cabs to prevent untrained individuals from operating cranes. Black boxes will provide an accurate picture of events leading up to accidents, and will contribute to the development of future safety systems.

If trends during the past 40 years are any evidence, the cityscapes of the next several decades will be punctuated by cranes that won't appear much different than the ones we see today. The changes will be inside, resulting in greater efficiency and safety as we build the skylines of tomorrow.

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SKI BOAT SHOOTOUT

(Continued from page 89)

within 10 ft. of transom at most speeds.

Rack-and-pinion steering makes handling flat-out runs through a tight slalom course a breeze and allowed the Supra to match some quicker boats, even though it had less top speed than others. A prop change would probably add some punch. Noise levels are very low at idle, but a resonance occurs at around 20 mph. At higher speeds, the noise level drops as low as any boat tested and vibration is minimal.

The Supra features a "Velvet Drive" transmission that eliminates the sharp jerk common when direct-drive inboards are put into gear—a plus for dockside handling. Only negative note in the driving tests was a tendency to wander slightly at maximum speeds.

A sunken footwell allows plenty of legroom in the cockpit, and the driver's seat was snug and solid. It was the only one in the fleet that allowed adequate space to enter and exit. The dash looks like something lifted out of a jet fighter, with all gauges easy to view with both hands on the wheel.

A unique feature in the Supra is the aft sunpad, which flips up to offer added storage space. Upholstery covers every interior surface, with all corners contoured for comfort.

Ski Supreme

The Supreme was a driver's favorite, with top scores on performance course and top end, and a second in acceleration. Differences between this boat and the top two were minimal—it wound up third by little more than a coin toss. The test team saw room for improvement in styling, but this is more a matter of personal taste than anything else.

The handling of the Supreme was awesome—it seemed to anticipate the driver and perform the sharpest maneuvers effortlessly. Cornering was incredibly tight—beyond anything the test drivers had experienced in previous tests. The boat also tracked perfectly and rode table flat.

The upholstery is functional, though not as stylish as some, and we found the driver's seat a bit shaky in high-speed cornering. The instruments are easily read with both hands on the wheel, and the speedos are mounted high so they can be monitored while keeping a lookout. Visibility through the windshield is good at all speeds.

The entire aft seat can easily be pulled out of the boat to allow more space for competition skiing, and an extra seat on the back of the engine cover gives the boat more capacity than most. However, we found walking space a bit cramped, and more storage pockets would be appreciated.

Negative chimes and a minimal 5° deadrise made the Supreme easy to ski behind, with very little spray and a smooth wake. Noise levels were acceptable at all speeds.

MasterCraft Pro Star 190

The Pro Star 190 is the boat used in all Cypress Garden shows and is an exceptional towing machine. A power slot in the hull allows for a larger prop than that found on most ski boats, and this gives the hull added stability and raw power when towing.

But the larger prop does have a drawback—middle-of-the-pack results with the radar gun and stopwatch. This and some small design flaws dropped the boat slightly behind the top guns.

The test drivers didn't like the low windshield, which sacrifices eye protection for unhindered visibility over the top of the frame. There's also a problem with the driver's seat placement—drivers of average height have a problem getting their knees comfortably positioned under the dash. The throttle position was somewhat awkward and the short lever is not easy to grip when wide open. We also found that the wheel position interferes with the view of the speedometers and tach.

We especially liked the upholstery work—the most stylish of any boat in fleet, with a luxurious, understated elegance. Large side pockets provide plenty of storage space for the little extras.

Hull construction, including all-fiber-glass stringers and massive aluminum engine mounts, was also impressive. Recessed hardware throughout guarantees that nothing snags the tow rope.

The boat's handling was very good, with quick and solid steering response. With a few minor design adjustments in the cockpit area, this boat could easily have earned a higher ranking.

American Skier

The exterior glass work on the Advance was mirror-like, without a hint of fiber print-through. The motor box was stouter than most and did a good job of keeping engine noise out of the cockpit.

In the acceleration test, the American Skier was like a greyhound out of the hole, because of the 12-in.-dia. prop as opposed to the 13-inchers used on most others. The prop had a downside as well, dropping the boat to third in top end and in the performance course, where higher pitched props are an advantage. Handling in turns was good, with slight skidding that's predictable and easy to control. The wake was flat, the spray moderate.

The boat does not come standard with an aft seat, and most families would probably opt for this extra. We found the interior fit and finish adequate, but

not quite up to standards set by other boats in the test. The forward passenger seat is an L-shape and is somewhat smaller than the others. Storage space, like seating space, is minimal. Most families would want more, though tournament skiers may not.

Ski Centurion Tru Trac II

The Ski Centurion was the only West Coast boat in the test and several things set it apart. Not surprisingly, it had a bright, snazzy look to the exterior and multicolored upholstery.

But the most unique detail is an S-rail shape along the sides of the hull. Projections stick out several inches beyond the chine line and are intended to hold spray down and add stability.

The bottom design is also unusually complex, featuring a tapered prop pocket at the transom to flatten the wake, and a center channel to feed water to the prop. A cavitation plate is standard.

Despite these and other design innovations, performance and handling problems caused us to rate the Centurion a bit below the other rigs. The steering ratio is too slow for a performance-type boat and results in a lack of certainty in tight corners. Also, the boat had a tendency to skid sharply. Our drivers felt like they were running a stretch limo through a Grand Prix course.

Top end also had problems. The boat porpoised enough to be annoying in any kind of chop. Tinkering with the cavitation plate would probably help.

Among the Centurion's strong points are a dash featuring a visual status report module that monitors the boat's electronic systems. Circuit breakers are on the dash within easy reach, and all instruments can be read with both hands on the wheel.

The exterior shading is in the gel coat, making it far more durable than the decals. A racing-style gas cap on the transom and copious storage space, with two large side pockets running the length of the boat, are nice touches.

Each boat was propped and tested by the builder before delivery to Cypress Gardens. The handling course was a slalom course run at full throttle, then wheeling 180° for a short straightaway. Three performance, acceleration and top-end runs were made with two adults aboard and matched fuel loads. Top-end speed, measured with a radar gun, is the average of runs rounded off to nearest mph. Performance course times were measured with a Heuer stopwatch. Compartment measurements were made to maximum depth, regardless of compartment shape.

Despite a few glitches noted in some models, we think both hard-core skiers and casual weekenders will be delighted with any boat in our test.

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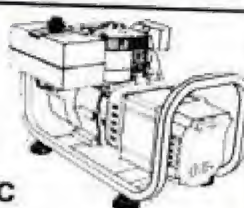
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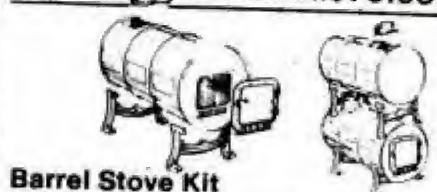
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AMERICAN HOT WAX

(Continued from page 81)

Twenty years ago, the recording studio was a place where musicians went to record albums—period.

Today, many of the top recording facilities in the world are equipped to handle digital audio scoring-to-picture for video and film, and a host of other specialized, audio/video marriages. Many are capable of digital satellite uplink and downlink transmissions, including London's Abbey Road Studios, where The Beatles recorded *Sgt. Pepper*.

Special effects were pretty scarce back when *Sgt. Pepper* was recorded, with tricks such as fluctuating the tape's running speed by hand used to provide sound effects. Most of the more common toys in today's studio arsenal simply didn't exist. This includes things that now are taken for granted, such as stereo chorus effects, pitch doublers and harmonizers, high-tech digital reverbs and delay lines.

In 1967, when the venerable Pepper taught the band to play, the grandest repository for their learning was a 4-track open-reel recorder—occasionally linked to another to provide eight recording tracks. In today's studios, equipment for recording 24, 32 and even 48 tracks is commonplace. Interestingly, cassette-based 4-track recorder/mixer systems now available to home enthusiasts for under \$1000 perform as well or better than the machines on which the Fab Four transcribed their landmark album. In fact, rock star Bruce Springsteen used a 4-track Tascam Portastudio for the home-brew stage of his *Nebraska* recording.

The advent of multitrack recorders and multitrack mixing systems has opened up new avenues of creativity for recording stars and technicians.

For purposes of clarity, "channels" refers to the number of input sources (microphones, electric guitars and so on) that can be fed to a mixing console. "Tracks" describes the number of positions or paths along the tape available for those sources. The mixing console is the traffic cop between the source channels and the tape tracks. If a 56-channel console is feeding a 32-track recorder, some of those input source channels will be blended or "mixed down" at the "board" to fit the tape track format.

Eventually, the multiple tracks on that 2-in.-wide studio tape will be variously assigned and distributed between a single left and single right channel, for stereo LPs, CDs and cassettes. But all those channels and tracks do not go for nothing. They enable the artist and producer to shape the recorded performance as they see fit.

For example, though there might be only four musicians in a band, the pro-

ducer might beef-up the performance by inserting background vocals or instrumentals on the extra tracks—even after the band has recorded its parts. The band itself needn't even record together. The lead singer can add his vocals after instrumentalists have "laid down" their tracks—or vice versa. In olden times, it was possible to add backgrounds by blending copies of the overdub and the original recording onto yet another tape—a process that degraded the sound. Today's digital recorders yield copies indistinguishable from the original, but thanks to the extra space available on multitrack equipment, even analog recordings suffer no loss of fidelity when overdubs are made.

Multichannel equipment makes all manner of musical manipulation possible after the actual recording. The drummer can be moved electronically to the left side of the soundstage from the right, as though that were the original physical arrangement. The recording can be rebalanced, to emphasize the sound on certain tracks over the others. This happens often in classical recordings. Because the home listener lacks the visual cues someone in the concert hall might see, the conductor and engineer might pump-up the channel that contains a violin solo—in effect focusing an acoustical spotlight on the soloist.

Imagine what it would be like for the Pepper boys to enter the control room of a professional 32- or 48-track recording facility today: The first thing to strike their attention, no doubt, would be the massive mixing console around which the room is centered. It's likely to boast as many as 56 or more input channels.

Boards on this grand scale almost always are equipped with on-board computers. These allow engineers and producers to keep track of the thousands of control settings, signal routings and complicated mixing moves. All this information is stored in the memory of large-capacity, specially formatted magnetic disks. When The Beatles were making *Pepper* in 1967, information of this sort could be maintained only on hand-written track sheets, and in the producer's and engineer's heads.

In front of the mixing console they'd find the studio monitors (a.k.a. playback speakers), either placed left and right atop the console or hung from the walls on each side of the control room glass facing the engineer.

The sound monitors, and even the mixing board, would be familiar to the old-timers. But nowadays, there is usually a video monitor or two mounted between the speakers and above the control room glass. This is used to synchronize the audio and videotape during music video post-production.

Directly in back, or to either side of the mixing console, they'd see metal

racks chock-full of signal-processing equipment (called outboard gear by the studio hands), as well as the multiple power amplifiers needed to make the whole thing sing. The signal-processing gear would include, among other things, Dolby tape-noise reduction units that didn't exist when *Sgt. Pepper* was in gestation—not to mention digital reverb systems and other "black boxes" of the studio magician's art.

Also behind the console they'd see multitrack tape recorders—either digital machines from Sony, Otari or Mitsubishi, or analog decks from Studer or Otari. There are also 2-track mastering recorders for use during mixdown, where the multitrack tape is boiled down to one left and one right channel prior to mastering for a stereo album.

One reason *Sgt. Pepper* was unique for The Beatles is that it was the first time they used an electronic music synthesizer—an early example of the instrument, called the Mellotron.

Unlike current synthesizers, the Mellotron did not electronically create sounds of instruments such as flutes or violins. The Mellotron actually used tapes of those instruments, housed inside the large keyboard. Striking a key activated the tape of, say, 100 violins, playing a "C" note.

Today's technology has updated that concept significantly—and created some potential legal hazards.

Many studios are now equipped with instruments called digital sampling synthesizers. These keyboards are capable of recording any sound digitally, storing it in memory, then allowing the user to play back the sound over the entire musical spectrum on the keyboard.

Chances are you've probably heard one of these synthesizers. Jan Hammer, the composer/musician responsible for scoring "Miami Vice," uses a \$100,000 Fairlight Computer Musical Instrument to create whole orchestral scores, as well as 12-string guitars, vibraphones, drums, horns, woodwinds, and other instruments. Not a single instrument heard on that TV show score is being played by a live musician!

And there's the rub. Musicians' unions complain that these samplers are cheating musicians out of studio work. Also, because sounds created by real musicians are being recorded or sampled for use in the Fairlight's sound library, the unions say that these musicians should be eligible for royalty payments each time their sounds (or performances, in a way) are heard.

It's a confusing issue that eventually will have to be hammered out, perhaps in a courtroom. For the meantime, samplers are here, and they're not going away. They're just one more part of the space age technology of the modern recording studio.

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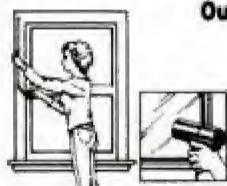
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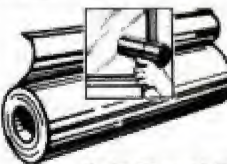
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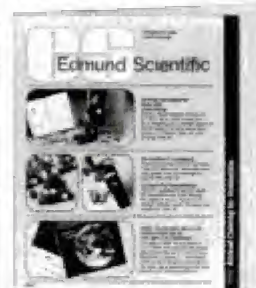
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Why Are We Giving Away Nationally Advertised GFX "Celsius-9"™ Chronometers (Not for \$49.95) only \$19⁹⁵



• Never needs winding

• Sweep-second hand

• Rotating bezel for measuring elapsed time

• Chime alarm for wake-up and appointments

• Luminous numerals

• Tachymeter times average vehicle speed over a "measured mile"

• Powered by mercury cell (already installed)

• Analog dial plus digital readout

• "Zero Refraction" matte black finish chain link band

• 12 and 24 hour (civilian and military readings) time modes

• Tells time in 2 different time zones simultaneously

• Stopwatch accurate to 1/100th of a second

• Displays month, date, day.

• Photon dispersion beam lights up time in dark

• Water resistant to 5 atmospheres (150 ft.)

• Accurate to within seconds per month

• Scratch-resistant mineral-glass crystal

• Sonic beep on the hour keeps track of time

• Stainless Steel case back

(ENLARGED TO SHOW DETAIL)

As part of a nationwide publicity campaign, a leading New York firm will give away its most expensive precision watch—the Nationally Advertised GFX "Celsius-9" Chronometer—for the astonishing publicity price of only \$19.95 to every person who writes to the company address (below) before Midnight, December 25, 1987.

This original publicity ad must accompany your request. Copies or photostats are not acceptable.

Similar chronometers have been nationally advertised and featured by others in leading media at \$49.95 each. In fact, you might think watches with features like these would sell for well over \$100.00. But, during this nationwide publicity campaign, you don't pay \$100.00—or even \$49.95. You pay only \$19.95! But your request must be mailed no later than Midnight, Dec. 25, 1987.

Powered by a computer-type chip and precision quartz movement, each GFX "Celsius-9" watch is a time-keeping "control center". Its tri-level, high-tech face includes an analog dial with sweep second hand, a multi-function LCD digital read-out that records time in both 12 and 24 hour (civilian and military) modes and a rotating bezel to measure elapsed time. The ultimate in a man's wristwatch, this GFX "Celsius-9" tells you the time in two time zones (while traveling); chimes the hour to remind you of passing time; keeps track of the day and date; awakens you from sleep; and is even water resistant to five atmospheres.

One of the most technologically sophisticated watches ever sold

by this multi-million dollar New York firm, the GFX "Celsius-9" features a Stopwatch/Chronograph (accurate to 1/100 of a second); a Tachymeter that times average vehicle speed over a "measured mile"; and, unseen, an amazing photon dispersion beam—smaller than the "eye" of a hornet—lights up the mineral-crystal in the dark.

This handsome high-tech "zero refraction" matte black time-piece is perfect for the office, sporting events (as player or spectator), that special night-on-the-town or just everyday wear. No wonder this is destined to be the fastest selling and most expensive chronometer of its kind ever sold by this multi-million dollar New York firm.

These GFX "Celsius-9" watches will not be sold at this or any other price by the company in any store. There is a limit of two (2) per address at this price, but if your request is mailed early enough (before Dec. 17) you may order up to 5. Each GFX watch is covered by the company's full one-year money-back guarantee.

TO ORDER: Mail this original publicity ad (no copies or photostats) together with your name and address and \$19.95 for each watch. Add only \$3 shipping no matter how many watches you request. (New York residents add sales tax.) Allow up to 6-8 weeks for shipment. *Make check payable to RBM Ltd.* Mail to: RBM, GFX Watch, Dept. 114-117, Box 1085, Hicksville, New York 11855. (R44640)

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Eastwood AUTO RESTORATION TOOLS

New Design! Spotweld Perfectly in 6 Seconds



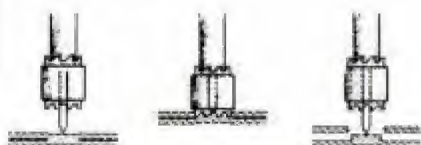
Converts an Arc Welder to a Spot Welder

It welds any steel between 18-26 gauge. (Auto body sheet metal is between 18 and 22 gauge). Ideal for welding replacement panels, floors, brackets, clips, braces, etc. Welds from one side so it can even do blind panels that ordinarily can't be spot welded. Comes with two pressure heads — four prong for control on flat areas and two prong for reaching into edge and recess work. Proper replacement electrodes

available through Eastwood. Gun comes complete with connection wire, spare electrode, 2 pressure heads and complete instructions. Hook it to the electrode holder of your AC arc welder (set at 50 amps) and ground to car body.

4325 Spot Weld Gun \$39.95
4321 Package 10 electrodes \$9.75
4347 Powerpack for spotwelder \$129.00
(If you don't have an arcwelder)

Cut Spotwelds In Seconds



Remove spotwelds without cutting through the lower panel. 1/4" arbor has adjustable pilot to insure perfect cuts without damaging metal. Pilot pops out slug after cutting. Works on air and electric drills (900 r.p.m. max.) with 1/4" chuck. Use with sheetmetal up to 3/16".

3219 Spotweld Cutter \$12.95
3220 Replacement Cutter \$4.50

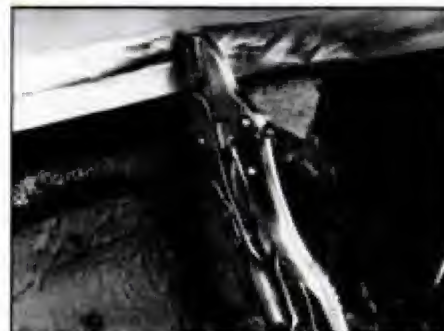
Auto Restoration Books



Here's a selection of the most popular restoration books in the Eastwood library.

6602 Key to Metal Bumping—how to use body and fender tools \$6.50
6600 Auto Restoration Tips and Techniques—A favorite reference book! \$9.95
6645 Auto Body Solder—the Bible of body solder repair work \$6.95
6601 Auto Body Repair—professional techniques explained \$16.95

Flangers For Flush Welds

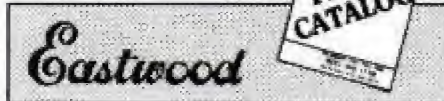


Offset Gives
Smooth Lap Welds

Adjust tool to metal thickness, flange repair area and lay in patch panel. Lets you weld flush with body metal, which minimizes grinding and filling. Works in tight areas and on sharp curves. Perfect results with very little effort.

6286 Panel Flanger \$29.95

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6281 Nibbler \$28.95
6284 Replacement Blades (pkg. 2) \$9.95

Get the Lead ... In



The EPA figures there could be as many as 70 million "high risk" engines likely to suffer "valve-seat recession" and other engine damage due to the removal of lead with its lubricating properties. Eastwood's Lead Substitute is chemically compounded to help protect valves and valve seats. Protects the engines in all gasoline engined cars, trucks, boats, farm equipment, etc. Add one bottle per tank of fuel (16-20 gallons of gasoline). Sold in cases of 12-8 oz. bottles. NOT FOR USE IN UNLEADED FUEL VEHICLES.

2802 Lead Substitute-per case of 12.... \$26.95

High Temp. Stainless Paint For Exhaust Systems



Our unique formula of corrosion resistant stainless steel leafing pigments bond to a metal surface to block out rust. Unaffected by the hot and cold cycles of automotive use, this coating will last for years.

Easy to apply, just clean the part with a wire brush. No primer necessary. Can be brushed, air dries in 60 min., and cures in use to maintain its maximum hardness and durability. Complete instructions on can. 1 pt. can.

1256 High Temp. Stainless Coating \$12.95

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3430 Oxi-Solv, 16 oz. \$8.95
3432 Oxi-Solv, 1 gallon \$24.95

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This is a heavy-duty auto shop brake for panel fabrication. Will form angles up to 90° in metal 24" wide with 18 gauge thickness. You can form narrower widths on heavier gauge metal. All welded steel construction with reinforcements to eliminate lifting and "bow". Mounts in any shop vise with a 2" opening and can be set up in minutes. Just insert metal, clamp holding bar in place, and lift handles. Produces a sharp, clean bend in steel and aluminum. Two 5" C-clamps required for use (not included). Weight 26 lbs. Minor assembly required.

6268 24" brake \$49.95
6271 Set of 2, 5" clamps \$14.75

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Serrations shrink dents without removing metal

Just attach this 9", 18 gauge stainless steel disc to your heavy-duty body grinder and you'll level stretched metal to its original factory-smooth shape. The secret's in the unique blade that creates heat to shrink metal back into shape. It has a 3/4" arbor to fit standard grinders (maximum speed 8000 r.p.m.; 5000 r.p.m. ideal).

7001 Shrinking Disc \$29.95

Prices in this ad supercede those of previous Eastwood ads.

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Most arc welders have been designed for joining 1/4" metal; our stitch welder attachment controls welding heat to produce smooth, even welds on body panels — limits distortion and burn-through.

The current's directed through an electrical solenoid and diode circuit. The solenoid, which pulses thousands of times per minute, gives you normal welding amperage while allowing you to weld thin pieces. Although the arc never appears to break, the reciprocating electrode action pulls the electrode in and out of the weld puddle to limit welding heat.

Welding's easy: once you strike the self-starting arc, lay the rod on the metal and let the machine do the work. Resulting bead is

smooth and even, with slag coming off in large pieces. Easy to master with practice.

The stitch welder's five foot power cord attaches to any A.C. arc welder's electrode holder (must run at 80 amps or less). Uses arc welding rods up to 3/32" steel and stainless. Tool body cast aluminum with vinyl insulated grip for positive control. Electrodes held with set screw and can be easily replaced. Designed for years of trouble-free service.

4369 Stitch Welder \$59.00

4377 Arc Welding Rods for Sheetmetal 3/4" Dia. Special Flux 3 lbs. Pkg.

(Approx. 120 rods) \$12.95

4347 Powerpack for stitch welder ... \$129.00
(If you don't have an arc welder)

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The Eastwood sandblaster package includes all-metal power (same as used on our larger units), ten foot hose, 14" pickup tube, spare nozzle and complete instructions. Just attach to 1 HP compressor, insert pickup tube into sand or other abrasive and you're ready.

8532 Sandblast Gun \$35.95

8534 Sandblast Gun & Hood \$49.95

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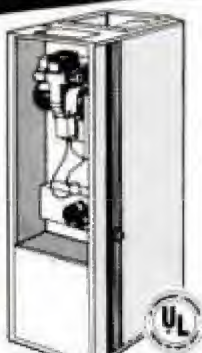
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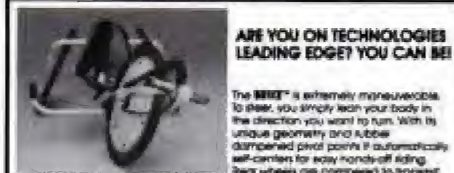
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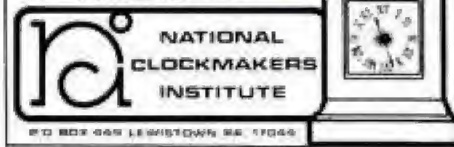
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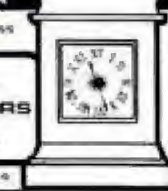
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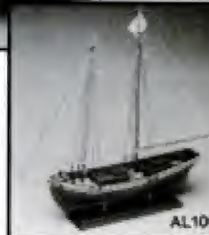
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Watch a professional modeler build a plank-on-frame ship model from a kit! Gives beginners an unfair advantage!

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Dept. PM-117

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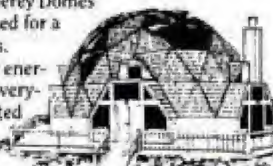
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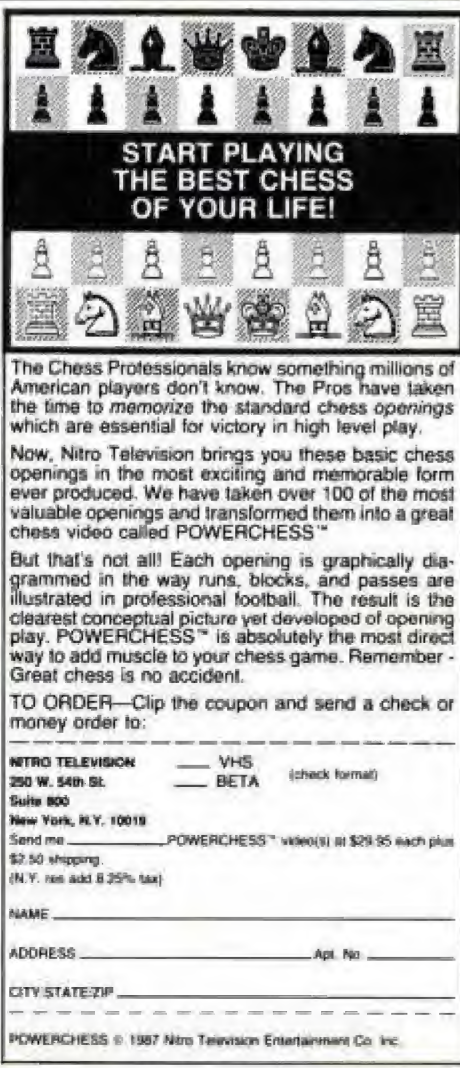
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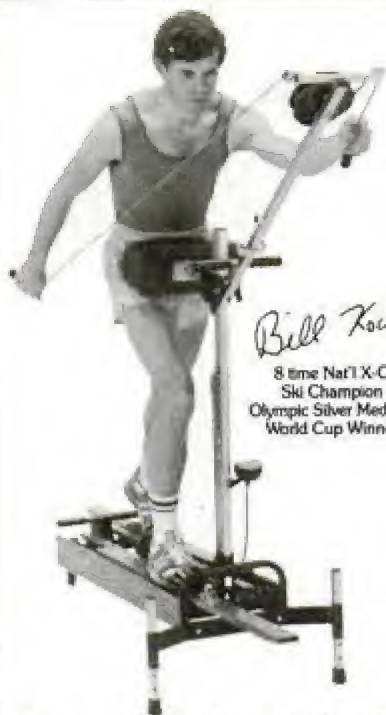
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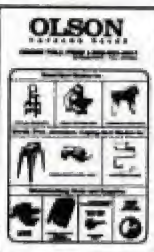
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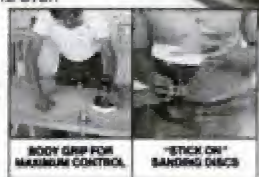
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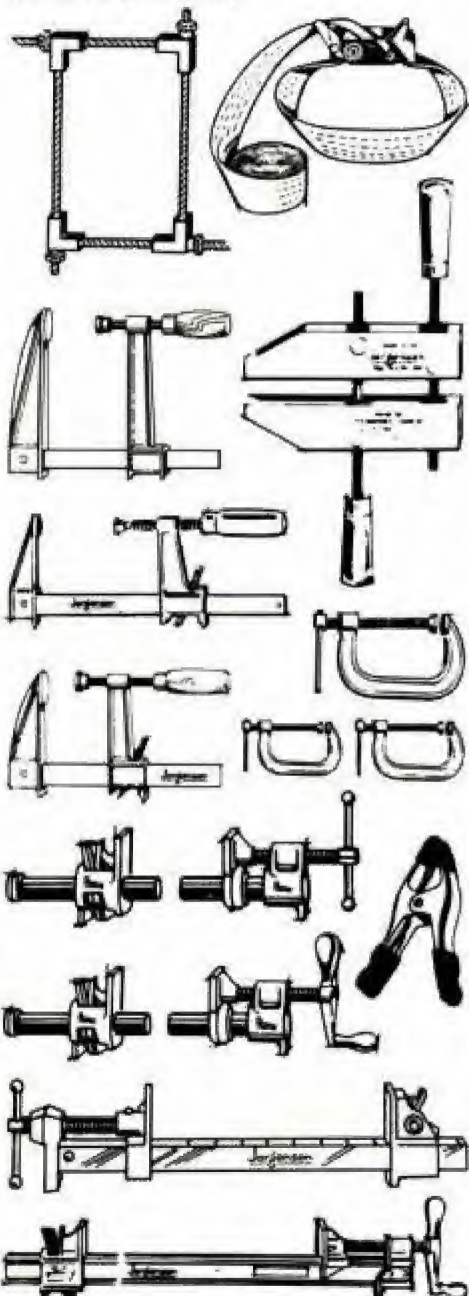
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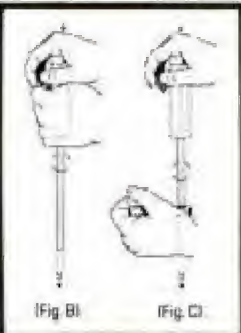
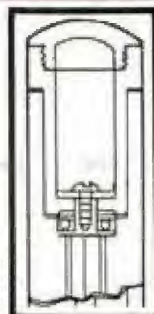
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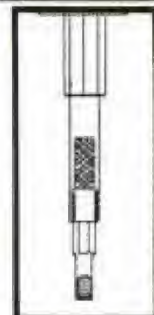
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(Continued from preceding page)

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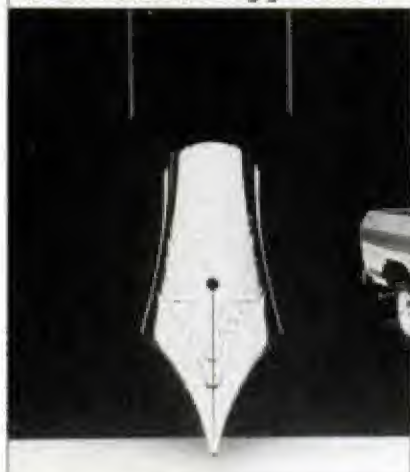
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